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ANNALS of SURGERY

A Monthly Review of Surgical Science and Practice

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ANNALS *of* SURGERY

VOL. LXIX MARCH, 1919 No. 3

THE FORMATION OF BONE

BY LEONARD W. ELY, M.D.

OF SAN FRANCISCO

(From the Stanford University Laboratory of Surgical Pathology)

AFTER Ollier described a cambium layer of the periosteum and ascribed to it a bone-forming function, his views were accepted almost universally until Macewen denied this function, and described the periosteum simply as a limiting membrane. Since Macewen's work was published a heated controversy has been carried on, which has attracted added interest on account of its relation to operations with the bone graft. Each side has presented arguments apparently incontestable, and has backed them with animal experiments.

When such a condition as this exists in medicine, investigation often reveals that each side contains a modicum of truth, that both miss the point, and that neither is exact in definition.

In order to avoid the last error, let us begin by laying down an exact definition of the terms we shall use.

1. *Bone cortex* is the layer of compact bone tissue at the surface of all bones. It is thick in the shafts of the long bones, but tapers off toward their extremities, and is continued under the articular cartilage as a very thin layer. In the shafts it is dense at the periphery, but becomes loose meshed close to the central canal. It is perforated by channels for the entrance of blood-vessels, and contains the longitudinal Haversian systems. It contains marrow throughout, the amount of marrow varying, of course, inversely as the density of the bone. Into it run prolongations of the periosteum, which bind the two tissues together. In other words, the cortex contains marrow and "periosteum."

2. *Marrow.*—"The soft fatty substance filling the medullary cavities and cancellous extremities of the long bones" (Stedman). This definition manifestly is not exact enough, for the marrow may consist in certain circumstances of little else but fibrous tissue, and the long bones do not enjoy a monopoly of marrow. Lippincott's dictionary defines marrow as "The fatty, oleaginous substance in the cavities of long cylindrical bones, and in the cavities of cancellous tissue." This makes the fatty substance the chief constituent of marrow, and is not exact enough for our purpose. Lymphoid marrow and fibrous marrow contain little fat, and a fibrous reticulum is a part of all marrow.

Dorland defines marrow as: "The soft material that fills most of the cavities and cancelli of the bone. It is made up of a mesh work of connective tissue containing branching connective tissue corpuscles, the meshes of the mesh work being filled with marrow cells, which consist variously of fat cells, large nucleated cells, or myelocytes, and multinucleated giant cells called myeloplaxes." This is a fairly accurate description of the constituents of most marrow. The first part of the definition should read "all" instead of "most." The mesh-work may be filled with the cells described or it may not. If it is not, the tissue is marrow, none the less.

The Century dictionary defines marrow as "the soft tissue found in the interior of bones, both in the cylindrical hollow of the long bones, and in the hollows of the cancellated bones."

Marrow is one of the most changeable tissues in the body. It is generally described as being of three varieties, lymphoid, fatty and "myxomatous." Whichever it is, it is always marrow. Its situation, not its composition, determines its name. Marrow is the soft tissue within the bone—all soft tissue within the bone. We may find in the marrow typical "marrow" cells, blood cells in various stages of formation, connective tissue, "osteoblasts," "osteoclasts," blood-vessels, fat. Wherever there is bone there is marrow, in the cortex, in cancellous bone, and in the central canal.

Typical marrow tissue is found not only deep in the cortex, but it pockets immediately under the periosteum. These pockets, as far as I know, have never been described. They are not numerous, but in examining a large number of slides, one occasionally sees them in the region of the joints.[1]

We have defined marrow as the soft tissue *within* the bones, and the lexicographers also define it as a tissue within the bones. This typical "marrow" tissue then cannot be marrow. It certainly is not bone. It must be periosteum, for it is outside the bone.

3. *Periosteum.*—This is the tissue which covers all bone, except at the joint surface. Its structure has been variously described. The question can be determined not by animal experimentation or clinical phenomena, but only by looking at the tissue under the microscope. If we do this we see that the periosteum consists mostly of fibrous connective tissue. Occasionally it consists of fibro-cartilage or hyaline cartilage. Sometimes one sees here and there a well-defined cellular layer, but generally one does not, and if one does not see a cellular layer, it is not there. The cellular layer is said to be more prominent in the bones of the young than in those of the adult.

The periosteum, as has been said, sends prolongations into the cortex, but by our definition they must become marrow as soon as they enter the bone. They certainly cannot be periosteum, for periosteum is the tissue outside the bone.

We have, then, outside the cortex typical marrow tissue, which is periosteum, and within the cortex typical periosteal tissue, which is marrow.

[1] Ely and Cowan: Bone and Joint Studies I. Stanford University, California. Published by the University, 1916.

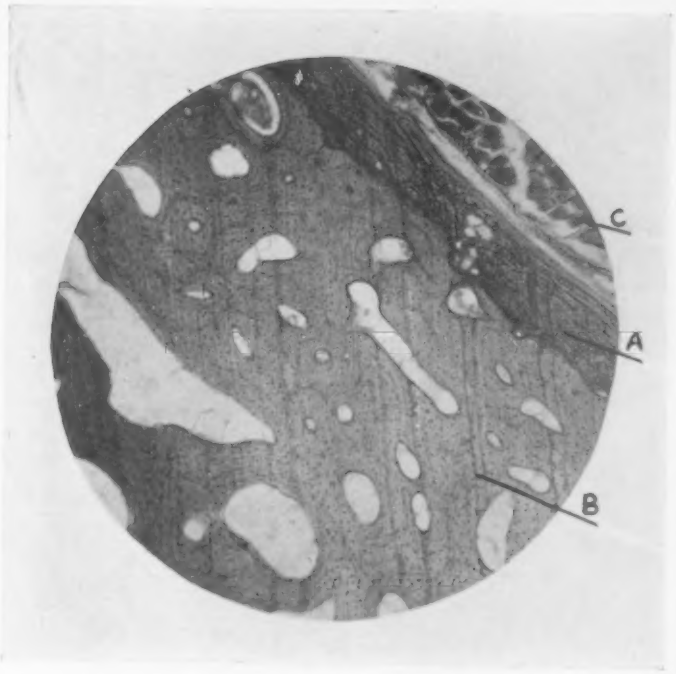

FIG. 1.—Low-power photomicrograph of lower metaphysis of adult femur. *A*, periosteum; *B*, bone; *C*, muscle.

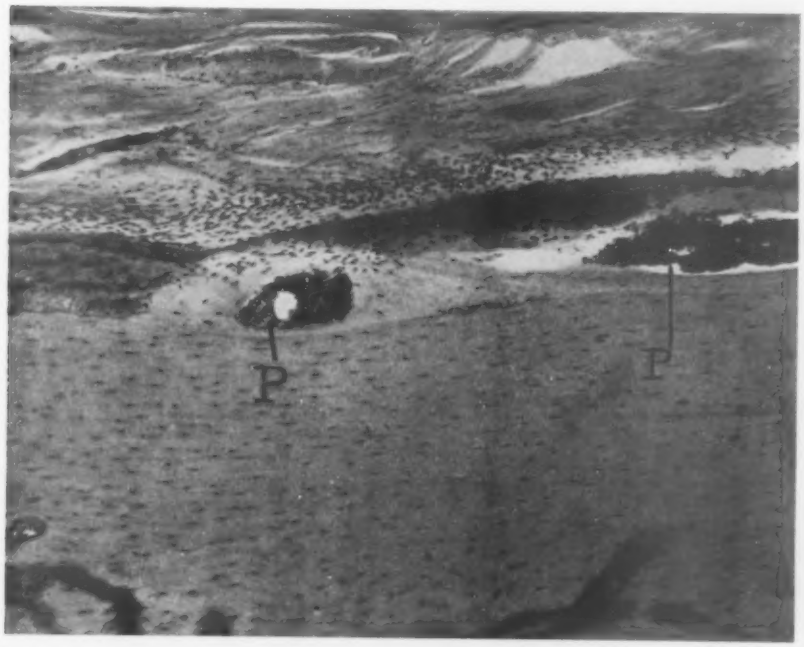

FIG. 2.—Low-power photomicrograph of bone showing narrow pockets (*P*) from human clavicle near the sterno-clavicular joint.

FIG. 3*a*

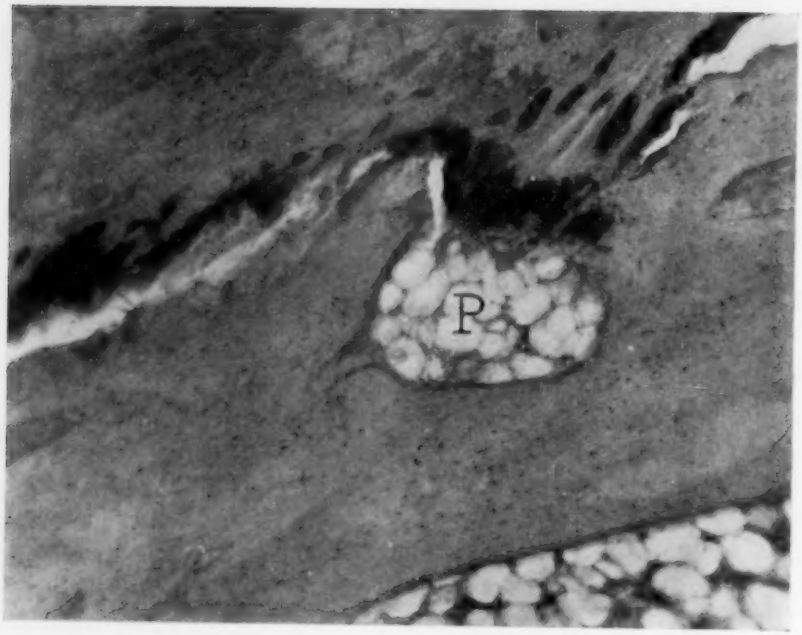

FIG. 3*b*

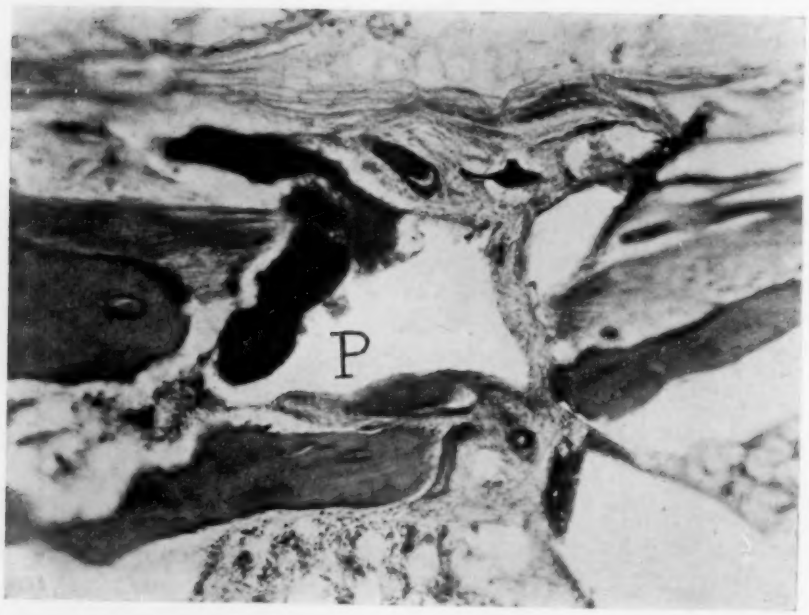

FIG. 3 *a* and *b*.—Photomicrographs of marrow pockets, also from a clavicle.

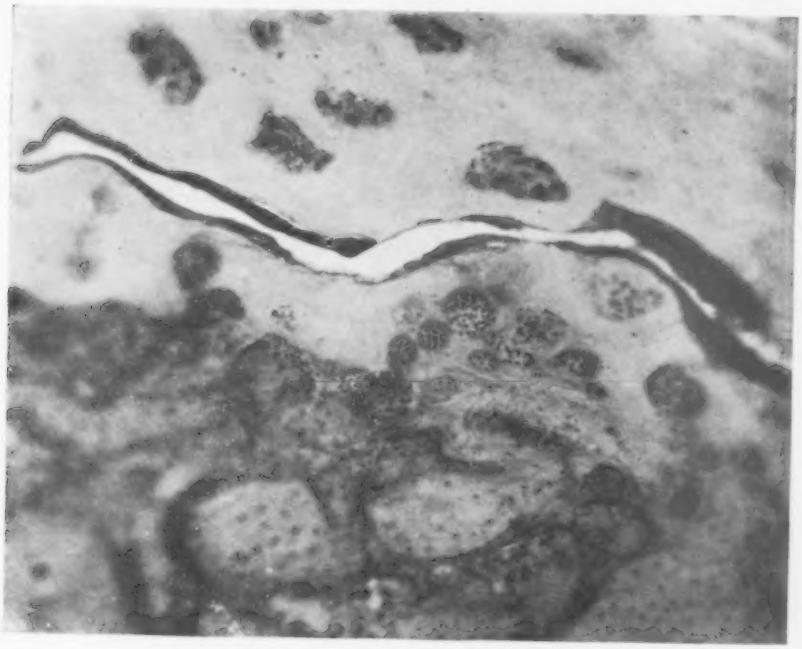

FIG. 4.—Photomicrograph of hyaline cartilage on the outside of a clavicle.

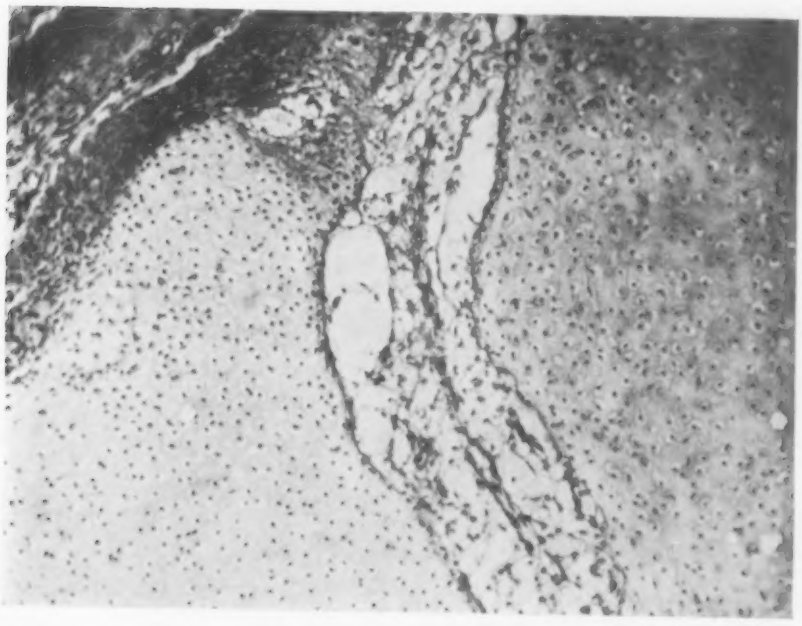

FIG. 5.—High-power photomicrograph showing vessels pushing their way into the cartilage; from the talus of a four-month fœtus.

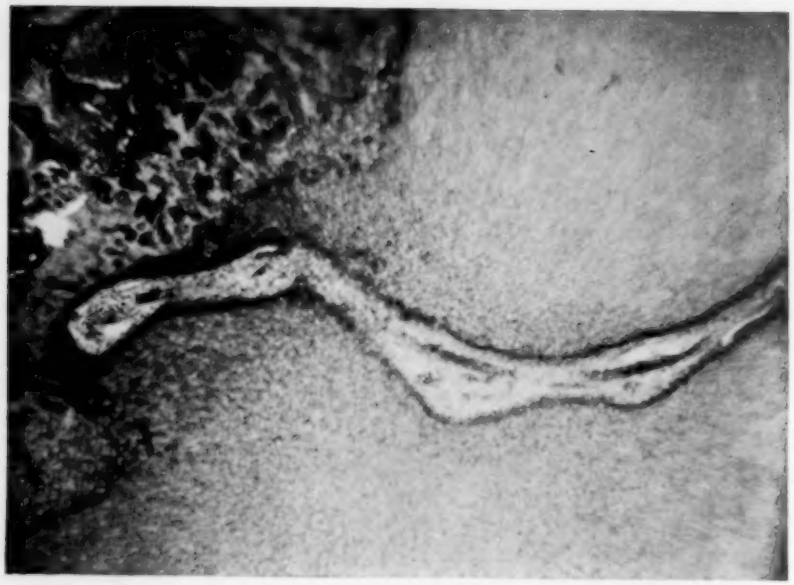

FIG. 6.—Lower power photomicrograph of intracartilaginous ossification, showing blood-vessels running through the cartilage to the bone nucleus; from the lower femoral epiphysis of a fœtus at term.

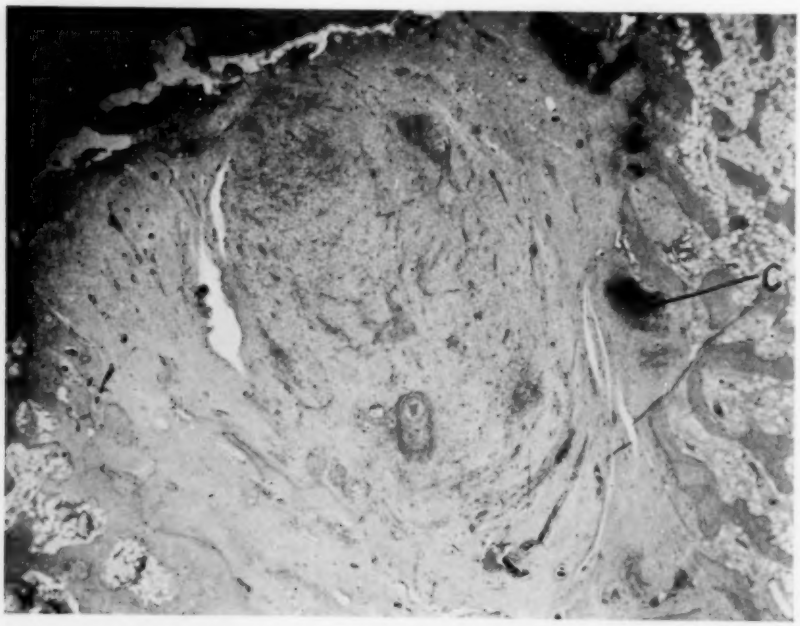

FIG. 7.—Bone formation around an old tuberculous focus immediately under the articular cartilage of the lower end of the femur. *C*, island of cartilage among the bone trabeculæ.

Let us turn now to what we know about bone formation, and see what we can gather from facts that we all accept.

1. Intracartilaginous bone formation begins with the pushing of blood-vessels into the cylinder of cartilage (in a long bone). Around these blood-vessels calcification and ossification take place. A similar process takes place later within the epiphysis. Here, then, is *bone formation without marrow or periosteum.*

2. Bone is formed without marrow or periosteum in the walls of the aorta, and in the kidneys of laboratory animals whose renal vessels have been tied off.[2]

3. Bone tissue is formed out of cartilage or fibrous tissue, within the bones, without the aid of the periosteum.

4. Bone is formed in fibrous tissue—intramembranous ossification, before any marrow is present.

5. Bone is formed on the outside of the cortex, beneath the periosteum.

6. Bone is formed in the periosteum, not alone on the cortex under it. This is not generally known. I show herewith a photomicrograph of new bone formation in the periosteum, from the tibia of a dog fourteen days after the resection of the knee in the immediate vicinity.

7. New bone is often formed in necrotic lymph nodes and in the kidneys.

8. Bone contacted with bone and enjoying a functional use, persists. Bone buried in the soft tissues, without function, slowly disappears.

If we sum up our facts we find that only three things are necessary for bone formation:

1. Blood-vessels.

2. Either a loose meshed fibrous tissue, or a homogeneous (cartilage matrix), or a granular or a necrotic material.

3. A stimulus, physiological or pathological, as the case may be. It is this stimulus that causes the blood-vessels to push into the cylinder of cartilage in the first place, and that causes the bone production in the aorta. This is perhaps vague, but we can go no farther at present.

It is seen, therefore, that neither periosteum nor marrow is necessary for bone formation, and that neither of them "forms" bone, in the proper meaning of the word. In each tissue the conditions are right for bone formation. The materials are there, and, given the stimulus, physiological or pathological, bone will be manufactured out of the fibrous tissue of the periosteum, or out of the fibrous or cartilaginous tissue in the marrow. The presence of bone is to a certain extent a stimulus for further bone formation. The true marrow cells, the characteristic marrow cells, probably have no function in bone building whatever.

The *osteoblast* is the bone-building cell, if the present theory of bone formation, the neoplastic theory, is correct. What is an osteoblast, and

[2] Liek: Zur Frage der heteroplastischen Knochenbilding. Archiv für klinische Chirurgie, 1906, lxxx, 279.

how can it be distinguished? It is generally thought to be a mesoblastic cell, but Geddes [3] says it wanders in from the epiblast. Moschcowitz [4] says it is simply an endothelial cell from the lining of the blood-vessels.

The osteoblast has no physical characteristics by which we can distinguish it from other cells, as has, for instance, the eosinophile, the myeloplax or the polymorphonuclear. It is described as a small, round or polyhedral cell with deeply staining nucleus seen on the surface of the bone trabeculæ or bone lamellæ. Its situation, in other words, is its distinguishing mark, like the man with an apron standing behind the counter in a butcher's shop. We recognize him as a butcher merely because we see him standing there. When we see these small cells lining the trabeculæ we say that "productive osteitis" is going on, and when we see giant cells in Howship's lacunæ we recognize "rarefying osteitis." This is only relatively accurate. The second is probably always true, but not the first. In certain inflammations in bone, notably tuberculosis and acute suppurative osteomyelitis, where we know from the X-ray picture and from microscopic examination that the bone is being absorbed, typical "osteoblasts" can be seen lining the trabeculæ. By all the accepted definitions of these cells new bone should be forming very rapidly, but we know it is not.

All that we can say about the osteoblast is that there is probably such a cell, of unknown derivation, and that possibly the same cell which can build up bone can also tear it down. When we see these cells edging the trabeculæ in bone that we know is building up, let us by all means call them osteoblasts, but when we see similar cells in the same situation in bone that we know is being torn down, let us not close our minds to the actual state of affairs and call the process productive osteitis.

The opinion I have derived from studying my bone slides is that when nature wishes to rearrange the architecture of bones, as after resections or fractures, or on the inside of the cortex in normal growth, she does it with the so-called osteoclasts. When, however, the bone is being absorbed as the result of an inflammatory process in the marrow, the active factor is a small cell, not to be distinguished from the typical osteoblast, and arranged in a row along the trabeculæ just like the latter.

The bone marrow is one of the most active, interesting and complex tissues in the body. We still have much to learn about it. Our knowledge will not increase rapidly if we form theories to start with, and then try to confirm them by animal experimentation. If new bone forms on transplanted periosteum in animal experiments, we are not justified in concluding that the periosteum "forms" bone, any more than we are justified in concluding that iron forms calcium oxalate because a hairpin in the bladder

[3] Geddes: Origin of the Osteoblast and Osteoclast, Journal of Anatomy and Physiology, 1912, xlvii, 159.

[4] Moschcowitz: The Relation of Angiogenesis to Ossification, Johns Hopkins Hospital Bulletin, 1916, xxvii, 71.

FIG. 8.—Photomicrograph showing new bone formation in the periosteum, from the tibia of a dog fourteen days after knee-joint resection. *T*, new trabeculæ.

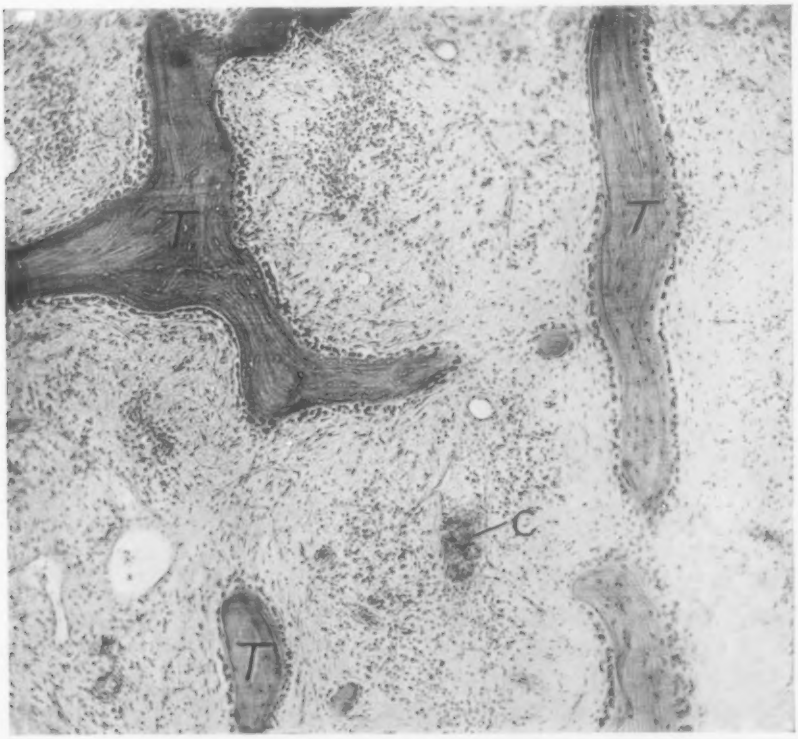

FIG. 9.—Photomicrograph of a section of bone from a case of acute suppurative arthritis. *T*, trabeculæ; *C*, colony of pus cocci. This illustration was published five years ago as showing "productive osteitis." The bone is being rapidly absorbed, many of the trabeculæ are dead, yet on the trabeculæ can be seen many cells which present the classical appearance of osteoblasts. Zeiss apochromatic, 16 mm. ocular 4. Tube length, 47 cm.

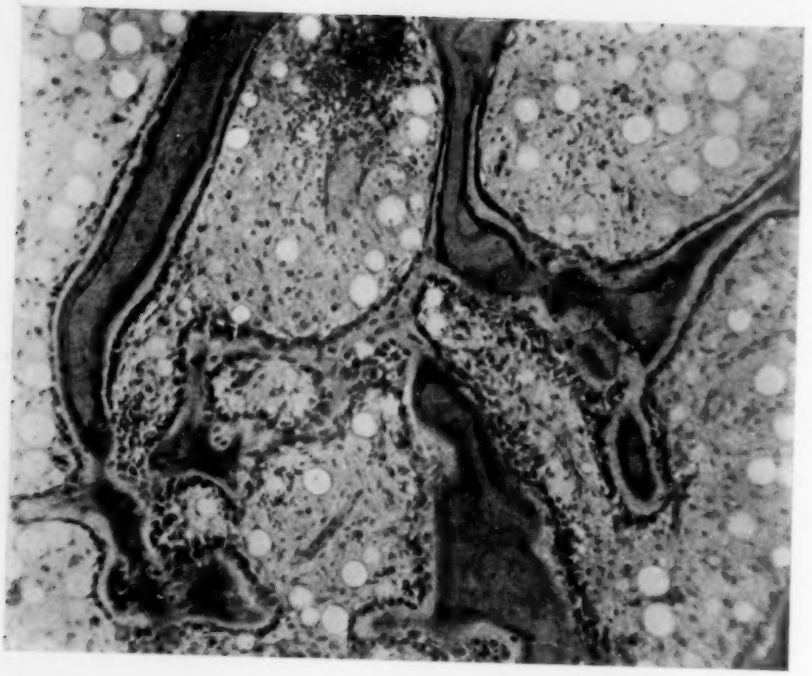

FIG. 10.—Photomicrograph of a section from a case of bone tuberculosis. The bone is being torn down, but the trabeculæ show in their borders what we are wont to call osteoblasts.

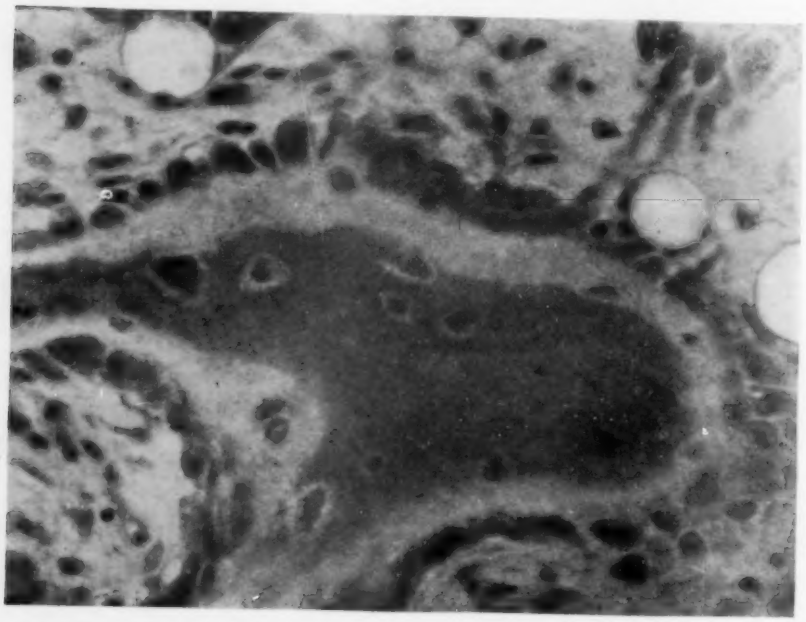

FIG. 11.—High-power photomicrograph of some of these typical "osteoblasts."

becomes encrusted with it. The fibrous tissue of the periosteum is the same as other fibrous tissue. If there are osteoblasts under it, they will form bone, as will any other osteoblasts.

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THE REPAIR OF CRANIAL DEFECTS *

By George Ewart Wilson, F.R.C.S. (Eng.)

Major, C.A.M.C.

The problem of repairing defects in the cranium has been brought prominently before the surgical profession by the war. Hitherto the number of cases coming under the notice of any one surgeon was very small, so that slight opportunity was afforded for the development of the best means of dealing with the subject. Moreover, in the pre-war days trephining was comparatively rare and the small opening left was quickly filled in by dense fibrous tissue which was almost as secure as the bony covering. To-day trephining is common and in the great majority of cases the hiatus is of considerable size and the cause of various disturbances.

Before attempting to remedy a defect in the skull it is important to make a very thorough examination of the patient with especial reference to the nervous system. Many of these men suffer in a greater or less degree from functional disturbances and these may or may not be relieved by the surgical procedure. Some are so mentally deficient that it would be unjustifiable to interfere. Again there may be some deep-seated lesion which could not be expected to be benefited by a restoration of the protective covering. Of course, if a foreign body be present it should be removed if at all feasible, but it must be kept fairly in mind exactly what is to be expected from the operation. We replace a yielding scar by a non-yielding substance and at the same time release the brain beneath the hiatus from the edges of the osseous opening and smooth down the dural edge. Consequently only those symptoms which can reasonably have a causal relationship with the pathological conditions remedied can be expected to be cured or relieved.

The symptoms usually complained of are headache and dizziness when suddenly stooping or turning suddenly. In addition there may be a feeling of fear lest the head be injured, lack of interest in their surroundings, inability to stand noise, blurring of vision and epileptiform attacks. The physical signs are visible pulsation and impulse on coughing.

Under such conditions the delicate structure of the brain is being subjected to frequent if slight injury, and unless contraindicated by some general disease like advanced diabetes or Bright's disease, calls for surgical intervention. Furthermore, it is quite proper to advise operation in those instances where the patient complains of nothing whatever, merely with the object of ridding him of a disfiguring deformity. Having determined that an operation should be performed it remains to be decided when and how.

---

* Read before the December meeting of the Academy of Medicine of Toronto.

Most surgeons are agreed that at least three months should elapse after the healing of the wound before interfering, although Woodroffe operates much earlier and so far has had no trouble. The great danger in early operation is the possibility of setting free latent infection; Harrison applies radiant heat to the scar previous to operating. If latent sepsis be present it is shown by inflammation in the cicatricial tissue which sometimes breaks down. In any case, it is well to bear in mind that the longer the period of suppuration the longer should we wait before attempting to repair the defect by any grafting operation.

The methods adopted to close cranial defects are now quite numerous and may be classed as follows: (1) bone grafts, (2) metallic plates, (3) cartilaginous grafts. Considering these in detail we find that bone grafts have been obtained and utilized in a variety of ways. Mayet (*Bull. acad. de Med.*, 1916) described an operation by means of which the external table with its intact pericranium was detached from the inner table over an adjoining and suitable area and swung round on a pedicle of pericranium in such a way that the outer surface of the graft came in contact with the brain. It was sutured in place and the scalp closed.

Le Fur in the *Press Med.*, 1918, describes a modification of the former operation which he calls dedoubling. Adjoining the opening a suitable piece of the external table and its pericranium is mobilized but left attached by a strip of the latter along the margin of the defect. It is then turned back in place. He reports thirty-seven cases, in six of which the breach was seven cm. in diameter. In no case was there exaggeration of the symptoms and nearly all were improved. He had one death from infection in the third week.

Autogenous tibial grafts are favored by a number of workers. Morrison in the *British Journal of Surgery*, January, 1917, reports twenty-one cases with no deaths. After turning down a horseshoe flap which includes the aponeurosis the pericranium is divided one-quarter of an inch from the margin of the hiatus and the outer table removed for half an inch to make a shelf for the graft. This is cut from the inner surface of the tibia, taking care to leave the crest as his second patient sustained a fracture of the leg which he attributed to his having failed to leave the anterior border. The periosteum is left longer than the bone to allow of its easy suture to the pericranium. If the area to be grafted is convex as is usual the graft may be bent by saw cuts which leave the periosteum intact. The graft is placed with its deeper surface against the scar in the brain. His first operation, owing to the large size of the hole, had to be done in two stages. At the second operation, four months later, there was firm bony union, and no excess of callus. He draws attention to the fact that in all his cases there was tenderness in the grafted area for about six or eight weeks. Instead of the tibia some surgeons use the ribs. Brown, in the *Med. Journal of Australia*, 1917, reports thirteen cases in which the defect was closed by this method. The rib is removed in

such a way that the periosteum on the outer surface is left attached while the deeper portion remains *in situ*. The rib is then split into outer and inner halves, and the former is fitted into the defect in such a way that the membrane covered surface is outermost. The advantage claimed over tibial graft is that they are more easily obtained, and the ribs have a rounded contour.

In a few instances other autoplastic bone grafts have been used. Monclaire made a graft from the great trochanter while Leclerc resected a portion of the scapula. Heterogeneous bone grafts have been employed on a few occasions, Macewen and Richard having each utilized the bones of a dog, while in Lexer's clinic the horns of cows have served the purpose.

Of the methods thus far dealt with the bone graft has been taken from a living subject. In *Presse Med.*, 1917, Sicard Dambrim and Roger describe the operation which they perform. A piece of skull of suitable size is removed from the cadaver. It is perforated by small holes 0.5 cm. apart, and scraped on the under surface till the diploic tissue is seen, the resultant thickness being ½ cm. The edges are bevelled. It is then carefully sterilized but not decalcified and tested for bacterial growth before using. After freeing the flap the pericranium is incised 1 cm. all around the opening and stripped up in both directions. The inner strip left attached to the edge of the opening is then thrown over so as to lie against the brain scar. The graft is inserted between the outer strip of pericranium and the bone. They admit having had trouble with their first operation owing to faulty technic, but in the last forty-two the results have been uniformly successful. In one case they had occasion to reopen the wound four months later, when they found the grafts well fixed in the original position and with the perforations in the graft choked with fibrosseous tissue.

Metallic plates have had an extensive use during the war.

Mitchell, in the *British Journal of Surgery*, July, 1917, reports six cases treated by perforated silver plates of a thickness rather less than the ordinary calling card. The holes are one-eighth of an inch in diameter placed as close as possible. The plates are placed beneath the pericranium and sutured with catgut. None of his cases suppurated, and he shows one after an interval of five months.

Estor, in *Bull. et mém. Soc. de chir.*, 1915, reports eleven cases treated by gold plates, one-quarter of mm. in thickness. Projections along the edges are left which fit into the diploe. One case died from abscess formation.

Noon, in *British Medical Journal*, March, 1917, reports three more cases treated by gold plates. All were successful, while Duval, in *Bull. et mém. Soc. de chir.*, 1915, gives details of three cases treated in like manner, but substituting aluminum for the gold which was impossible to obtain.

Cartilaginous grafts were introduced by Morestin of Paris. In his

first operation in which there was a large defect in the frontal region he used a homogeneous graft, while in the second the cartilage was taken from the patient himself. Both were equally successful. Since that time a large number of cranial defects have been treated by autogenous cartilaginous grafts and series of cases have been reported by Villandre, Gosset, Rouhier, Woodroffe, Gilmour and others. The operation as performed in the service of Colonel Primrose at the Toronto General Hospital is as follows:

After a tight-fitting layer of gauze has been placed over the prepared head, and an elastic tourniquet is tied around the base of the skull in the usual way, a flap of skin including the epicranial aponeurosis is turned down, a procedure which in certain instances is difficult owing to the close adhesion between the scalp scar and brain. The margin of the hiatus is then identified and the pericranium is incised all around it at a distance of a quarter of an inch. The pericranium is stripped up in both directions. The inner strip is freed to the margin and then the scar tissue adherent to the edge of the defect is likewise pushed inwards with a periosteal elevator until the dura is exposed. The latter is likewise freed for about a quarter of an inch, so as to examine for thickening or spicules which might cause injury to the underlying cerebral tissues. Any such abnormality is immediately dealt with. By means of an electrically driven burr the outer table is removed for a distance of about three-eighths of an inch all around the opening, the object being to make a shelf upon which to place the graft and at the same time set free osteoblasts. When the bleeding has all been controlled the wound is packed with gauze, wrung out of hot saline, and while the assistant keeps up a moderate pressure the surgeon proceeds with the cutting of the grafts. A vertical incision about six inches long is made two inches from the mid-lines, splitting the fibres of the rectus abdominis. The muscle is retracted and the cartilage of the sixth, seventh and eighth ribs exposed. If a larger graft is required the incision can be extended in either direction. Bearing in mind the size of the hiatus a suitable graft consisting of two-thirds of the cartilages is removed. This is the most difficult part of the operation, for the graft must be uniform in thickness so as not to bend readily. Then the graft should be removed in one piece. When the opening is 2 inches by 1½ inches there should be no difficulty in closing it with one piece, but when larger the graft is roughly Y shaped, and this must be so placed that the three corners rest upon the skull. Unless the graft has a firm support the end result will be disappointing in that the bulging on coughing remains. If properly done there will be no impulse. The grafts are immediately placed in warm saline, and when satisfied that sufficient cartilage has been procured an assistant closes the chest wound while the surgeon places the graft in position. Since the grafts take on a rounded shape with the convexity towards the cut surface, the smooth perichondrial side is placed next the brain. They

are layed on the prepared shelf, and beneath the pericranium which is stitched to the cartilage by means of a chromic catgut. In a large defect it will be found impossible to fill the defect with one graft, so that additional pieces are suitably placed and sutured to the pericranium and the cartilage of the main graft. When all hemorrhage has been controlled the flap is stitched in place with silkworm gut, a small drain is inserted and the wound dressed with a fairly tight bandage. The tube is removed after forty-eight hours, and the stitches in ten days.

The following is a brief summary of the cases so far dealt with in the clinic:

Case I.—H. S., age twenty-two, R. A. F. Hit by propeller November 29, 1917, at Fort Worth, Texas, and was unconscious for three weeks. Immediate decompression. Left hospital in January, 1918.

Complaint.—On admission March 2, 1918, dizziness on turning quickly. Headache in left temporal and occipital region, poor memory for recent events, deafness and noises in right ear.

Examination.—Well-developed man. There is a defect in the left frontoparietal region, measuring 2½ inches by ¾ inch. It pulsates and has an impulse on coughing and is depressed. On April 12th Colonel Primrose closed the defect by autoplastic cartilage graft taken from the right side, six separate pieces having been utilized. The convalescence was uneventful, stitches being removed by the 22d, and the wound was clean—no impulse on coughing. Then, on May 15, he started to complain of headache again, and chiefly occipital. Given three months' leave of absence, and was readmitted again in September complaining of headache (left occipital). The great occipital nerve was injected with alcohol on this occasion, but the relief was only temporary. It was observed now that the grafted area was not as firm as it was, especially in the anterior part, where there was some bulging when he coughed.

Case II.—T. Y., aged twenty-four years, admitted May 16, 1918, discharged August 23, 1918. Wounded November, 1917, in two places, one over frontal bone above right eye, and extending into hair, being 2 inches by 1 inch, the other in the occipitoparietal region on right side about 1½ inches above right ear, and 1 inch square. Was unconscious three days.

Complaint.—Constant dull headache over frontal area. Has had two fits since returning. Has never been dizzy, but vision is blurred in left eye.

Operation (May 22, 1918).—Colonel Primrose. Marked thickening of margin, laterally. Dura opened at one point and cerebrospinal fluid escaped.

On June 2d, patient had a convulsion, otherwise convalescence normal.

Operation on Second Defect.—Colonel Primrose. July 12, 1918. Dura again opened in one place, and a sudden convulsive movement of the leg occurred during the manipulation. The next day he had a con-

vulsion which was relieved by removing dressing. On 16th there was considerable serous discharge and the next day purulent culture showed streptococcic infection. Scar in centre and flap sloughed on 24th, and a suture of catgut came away. On May 18, 1918, the scalp was dry, and patient transferred to Whitby. At that time patient felt stronger and had lost his headache.

CASE III.—W. F., aged twenty years, admitted May 22, 1918, discharged June 27, 1918. Wounded October, 1917; unconscious for only a few hours following wound. Never headache, loss of memory, or other disturbances, only weakness of hand and leg for two months after wound. Large hiatus in left parieto-occipital region, 3 inches by 1½ inches. Impulse on coughing present and pulsation.

Operation (May 29, 1918).—Colonel Primrose. In this instance scar (central part) was excised. Scar very adherent in places, so dura was opened at the post margin. Bony rim was rough and a spicule was found to press inwards. Some tension on flaps when sewn.

Slight pulsation on coughing remains, and has had some headache since the operation.

CASE IV.—F. C., aged twenty-six years, admitted July 5, 1918, discharged August 30, 1918. Shrapnel wound, April 9, 1917, of left frontoparietal region. Immediately after the injury he had a fit and was paralyzed on the left side. Was unconscious for three weeks. A fortnight later the paralysis cleared up on the left side and the right side was paralyzed. He doesn't know how long they lasted. The hiatus is 2½ inches anterior posterior and 2 inches in a vertical direction. It is markedly depressed, and pulsates on coughing or stooping. Scar is densely adherent to the tissues beneath. It is tender on pressure.

Fits have been very frequent ever since. Sometimes as many as three a day. Has an aura, which consists of twitching of fingers and thumb of right hand and a buzzing in the ear.

Symptoms.—Headache, chiefly frontal. Difficulty in breathing. Difficulty of speech. Loss of power to read. Is learning from first reader.

Operation (July 16, 1918).—Major Wilson. Scar very adherent and difficult to free from brain. Wound healed by first intention. Took three fits through the night, then only one more while in hospital. August 30th note says scar firm. When last seen there was an impulse in the anterior part of wound.

CASE V.—A. M., aged twenty-four years, admitted August 1, 1918, discharged September 27, 1918. Wounded November, 1917, the missile entering the parietal region and coming out in the occipital. Did not lose consciousness, but when he tried to walk found the right arm and leg very weak. Face was never paralyzed. Later at dressing station lost consciousness—lasting for ten days. At present the movement of the right ankle and foot is very poor, and he has homonymous hemianopsia.

Complaint.—Dizzy spells and faintness. Loss of memory for recent events. Dimness of vision. Weakness of right side of body.

Operation.—The parietal defect had been closed by Lieutenant-Colonel Gilmour at Orpington, April 17, by a tibial graft.

Operation on the occipital defect, which was 1¼ inches by 1 inch, was performed by Lieutenant-Colonel Gilmour on August 9th, the pieces of cartilage being placed over in a trellis-like manner, as advised by Villandre.

CASE VI.—A. W., aged twenty-eight years, admitted May 29, 1918, discharged July 18, 1918. Hit by shrapnel casing April 22, 1917, unconscious for eight hours.

Complaint.—(1) Dizziness when bending over. (2) Left frontal and temporal headache increased by sunlight. (3) Inability to open mouth.

Trephining (May 10).—F. B. removed from brain together with small piece of bone. Day following operation his left arm and leg were powerless. Discharged pus until Spetember, 1917. Since October, 1917, headache has been getting worse. Dizziness disappeared from September, 1917, to May, 1918, but is getting bad again. Lost memory for a month after operation. Jaw opens half way.

Status Præsens.—No paralysis. There is a depressed scar in the hiatus which extends from the exterior angular process of the frontal bone to just above the exterior auditory meatus and reaching 1½ inches above the zygoma on the left side. There was no pulsation but slight bulging on coughing.

Operation (June 12, 1918).—Major Wilson. In this case the temporal muscle was firmly adherent to the scar over brain and explained why he could not open his mouth properly. Hiatus closed with cartilage in one piece, the lower portion tucked in under the muscle to prevent adhesions again. The day following the operation patient was advised to keep the jaw moving and he could open it freely. This led, however, to considerable oozing of blood, which, by the sixteenth, was serous in character, but by the eighteenth, or six days after operation, was definite purulent and culture showed a streptococcic infection. On July 1st a small piece of cartilage came away and shortly after the wound was healed and firm.

His dizziness disappeared, and so did the headache except for an occasional slight attack. The jaw movement was increased about 10 per cent.

CASE VII.—D. S., aged twenty-four years, admitted May 11, 1918, discharged June 25, 1918. Hit by shrapnel May, 1917. Unconscious three days. Shrapnel removed at base hospital. In bed four months. Defect to right of midline in the frontal bone over right eyebrow and extending into hair. There is marked pulsation and an impulse on coughing.

Complaint.—Dizziness and headache, memory is good.

Operation.—Major Gaby. On May 21st dura opened in this instance and considerable cerebrospinal fluid escaped. In separating dura from the edge of hole some spicules were found protruding.

These were removed. June 7, 1918, patient up in chair and no headache or dizziness.

CASE VIII.—W. C., aged thirty years, admitted May 15, 1918, discharged June 27, 1918. Shrapnel wound, May 22, 1916. Wound remained open until July 12, 1916.

Status Præsens.—A large defect in the right frontoparietal region of an irregular shape. It pulsates freely on coughing. There was ptosis of right eye and total blindness on that side.

Complaint.—(1) Buzzy noise in right ear. (2) Dizziness. (3) Right side headache. Attacks of tingling sensation in both hands and extending up the arms when excited. Twelve in number and consciousness is lost.

Operation (May 23).—Lieutenant-Colonel Gilmour. Transplant in one piece. Slight pulsation remained and headache was still complained of.

CASE IX.—W. A., aged twenty-nine years, admitted November, 1917. Unconscious at once, lasting three hours. Metal fragment removed at C. C. S. Paralysis of entire left side.

Status Præsens.—Healthy looking man. Memory for recent events poor. Headache in parietal region since injury. Dizzy spells on stooping or when walking. Headache. Fits, the first occurring in February last. Once a month about June. Has an aura of choking sensation in throat some minutes before nausea. Hiatus about the size of half dollar in left parietal bone over prominence. He has a chronic suppurative otitis media of left ear. On September 2d he had a fit.

Operation (Lieutenant-Colonel Gilmour).—The cartilage being placed between a lattice work of chromic gut. Wound healed first intention and he was discharged on October 17, 1918. No note as to improvement.

CASE X.—J. T., aged twenty-six years, admitted September 19, 1918, discharged November 27, 1918. Wounded August 15, 1917. Had aphasia and right hemiplegia following injury.

Status Præsens.—Patient is a healthy looking man, but there is a pulsating defect over the left parietal region. The scar is very adherent.

Complaint.—(1) Headaches and dizziness. (2) Weakness of right side. (3) Deficient memory and speech. (4) Fits.

First fit occurred in March, 1918—that is, about seven months after being wounded. Has had them frequently since. They commence in the front, but only occasionally is consciousness lost.

Operation (September 23, 1918).— Lieutenant-Colonel Gilmour. In this the scar was excised, cartilage was placed between lattice work of chromic gut.

September 24, 1918, patient was very irrational, and had one fit.

The next note on the history shows that both the scalp and chest wounds are sloughing with considerable discharge of pus.

On November 4 the cartilage grafts came away together with a lot of suture material.

By November 24 the scalp was healed and the interesting note was made that pulsation was invisible, although it still bulged on coughing.

CASE XI.—J. W. M., aged twenty-two years, admitted November 12, 1918, discharged November 30, 1918. Wounded October, 1917. Had a silver plate inserted in England, but the wound became infected, and the scalp never healed over, so was later taken out after six months. Completely healed since June.

Status Præsens.—There is an irregular defect over the right fronto-parietal region, which pulsates freely. Headache with sharp shooting pains over the left frontal region, dizziness on becoming heated.

Operation (November 16, 1918).—Colonel Primrose. In this instance the central scar was excised and the scalp retracted. The next night he had a slight seizure, so the bandages were loosened.

On November 20, 1918, the wound firmly healed. No impulse on coughing. Has had no headache since.

CASE XII.—C. R. F., admitted November 8, 1918; still in hospital. Wounded in right knee on October 26, 1917. The thigh was amputated. Three weeks later a metastatic abscess developed in the cranium which resulted in a sequestrum two inches by three inches, which was removed on the 21st of January, 1918. The scalp has been healed since May last.

Status Præsens.—The defect over the mid-parietal region on the left side is nearly ¾ inch. There is slight pulsation on coughing, and the scar is firm.

Complaint.—Headaches which come on at various intervals, often goes three or four days without them, hot sun aggravates them, dizzy attacks about once a week, always at night and usually after going to bed, sensation of bed upsetting.

Operation (November 20, 1918).—Captain Shenstone. Grafts placed in the usual way. In this instance there was latent infection in the tissues and the wound became septic so that on December 10th the cartilage was removed. Was discharged January 7th, at which time the cough impulse was distinctly less than originally.

CASE XIII.—C. K., aged twenty-two years, admitted November 5, 1918; still in hospital. Wounded on April 16, 1918. Was not rendered unconscious but very dull that night.

Status Præsens.—There is a defect in the right frontal bone 2½ inches in circumference, which pulsates freely and is tender to pressure.

Complaint.—Headache, inability to stand noise.

Operation (November 13, 1918).—Captain Shenstone. The only difficulty encountered was at the narrow inferior angle of the hiatus, where the separation of the dura was difficult. Although the dura was not opened in this instance, some fluid which closely resembled cerebrospinal fluid came away for some time, but that has now ceased.

At present the headaches are probably worse than before.

ON SOME LESIONS OBSERVED IN OPERATIONS FOR OLD INJURIES TO THE SPINAL CORD, WITH REMARKS AS TO TREATMENT *

By Charles A. Elsberg, M.D.
of New York City

Most of those who have sustained an injury to the vertebral column and spinal cord—whether a fracture of the spine or a bullet or high explosive wound—have an irremediable cord lesion to which they will succumb sooner or later. In a small number the injury to the spinal cord and its nerve roots is not severe so that improvement with or without surgical interference is possible. A certain number of patients are seen by the surgeon many weeks or months after the trauma; some of these will require operative interference.

Among more than 200 spinal operations performed on my services at the New York Neurological Institute and at Mount Sinai Hospital, a number of old traumatic lesions have been met with. They may be divided into (1) those involving the membranes and (2) those of the cord and roots, including the roots of the cauda equina; combinations of these types are usually observed in a single patient.

1. *Lesions of the Spinal Membranes.*—Changes in the dura are a very frequent result of trauma to the spine. In the mildest cases, the dura is not thickened, its external surface is normal in appearance, but its internal surface is congested and has, over the affected area, lost its glistening appearance. With these changes, a cloudiness and thickening of the arachnoid is often associated (Fig. 5). The dura may be so much changed and so greatly thickened that it exerts a pressure upon the cord very like that of an extramedullary tumor. This condition was met with in a patient (Fig. 1) in whom the beginning of the symptoms dated back to a trauma one year before. In this case, the excision of the thickened area of dura was followed by gradual improvement of the symptoms.

The dura may be dark brown in color and the extradural fat so much altered in appearance that it could very well be mistaken for an extradural neoplasm. When such a thickened dura is excised, great care is necessary in order that the cord beneath shall not be injured. If the cord is found to be adherent to the dura and the arachnoid sac obliterated, the dura must be freed with care. If the arachnoid sac is found to be shut off above and below the lesion, the arachnoid must be incised above and below, in order that the pent-up cerebrospinal fluid can again circulate.

Calcareous deposits are often found on the inner surface of the dura and they may cause root pains or marked cord symptoms (Fig. 2). These calcareous deposits—which must not be confused with the calcareous

* Read at the meeting of the New York Neurological Society, February 4, 1919.

plaques which are so frequent in the arachnoid and which have no known pathological significance—are very apt to be associated with a localized arachnitis and are often found very firmly adherent to the pia on the cord. Great care must be taken in their removal, for they are often so firmly attached to the surface of the cord that injury to the cord structure might easily occur.

Adhesions between the pia of the cord and the dura with obliteration of the arachnoid are often met with and form part of the scars that are so often seen on the cord after a trauma. In some instances the cord is compressed by a mass of scar tissue which stretches across from the inner surface of the dura on one side to that on the other, and causes symptoms very like those of an extramedullary neoplasm. Part of the cicatricial tissue may be so firmly adherent to the cord that its excision is impossible. In such a patient, carefully made parallel incisions may be made through the scar tissue in a similar way to the decompressive incisions that are often made through the scar tissue by which a peripheral nerve is enveloped. Cicatrices in the dura, especially around the roots of the cauda equina, may cause severe root pains. Fig. 3 represents the condition found in a patient who had sustained a fracture of the first lumbar vertebra several years before and who was operated upon in the Neurological Institute. His symptoms were entirely relieved by the excision of the scar tissue. If one or two sensory roots are found to have been much damaged—especially if the patient had root pains corresponding to the injured roots—it is advisable to divide or excise the affected roots.

The changes that may be observed in the arachnoid after a vertebral trauma vary within wide limits. As is well known, this membrane is normally very thin, perfectly transparent and is distended with clear fluid (Fig. 4). Sometimes the arachnoid is found to be slightly thickened and cloudy (Fig. 5) over the entire area exposed. At other times a localized area on one or the other side of the cord is thickened, cloudy and adherent to the inner surface of the dura, as was observed in one of my patients. More often, however, the arachnoid is not only thickened and adherent to the dura, but also has formed adhesions to the spinal cord, so that irregular cavities filled with fluid may result (Fig. 6). These cases—whether occurring from inflammatory disease or trauma—have been called "adhesive arachnitis," although this arachnitis must be considered a sign rather than a separate disease. New blood-vessels are apt to be formed if these arachnoid changes have occurred in the neighborhood of the posterior nerve roots (Fig. 7). If the vertebral trauma has been severe enough to cause a grave cord lesion, the arachnoid may have been destroyed and the arachnoid sac obliterated over a more or less localized area. In these patients we have found the subarachnoid space shut off above and below the affected area and filled by pent-up cerebrospinal fluid.

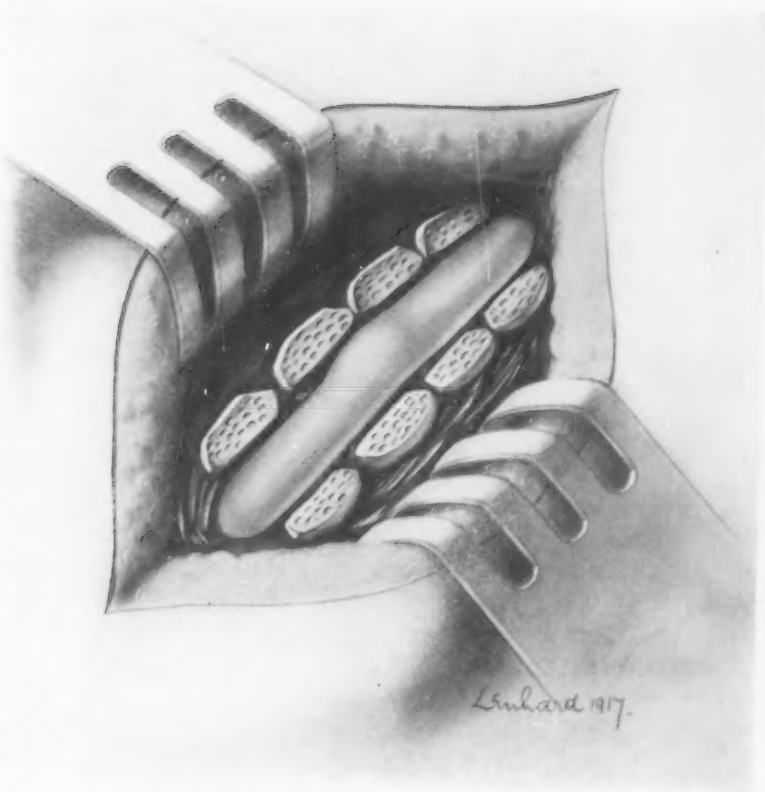

FIG. 1.—J. W. Pachymeningitis after trauma. Localized area of thickening of dura causing compression of cord. Appearance like that of an intradural tumor. Complete relief after excision of thickened dura.

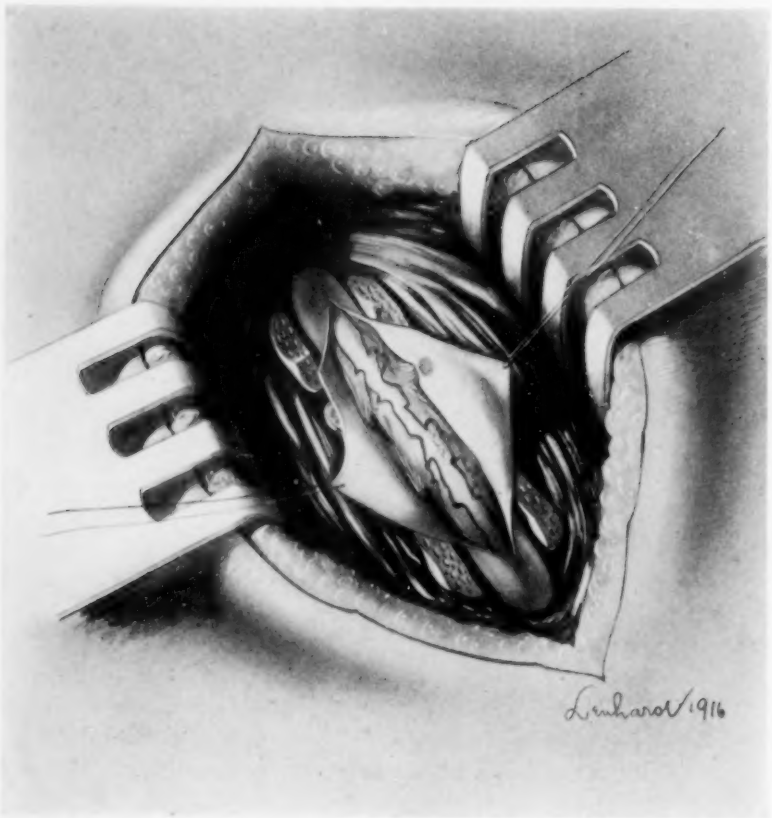

FIG. 2.—J. B. Calcareous deposit on inner surface of dura causing root and cord symptoms.

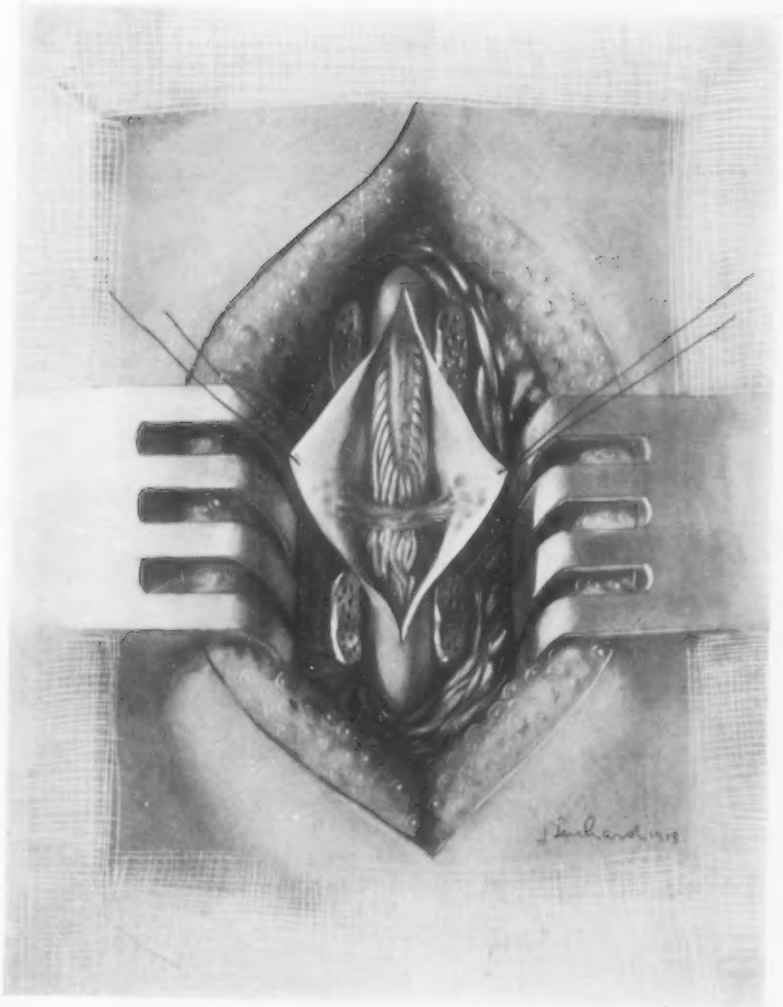

FIG. 3.—A.G. Compression of roots of cauda equina by cicatrix after old fracture of spine. Severe root pains. Excision of scar tissue. Complete relief.

FIG. 4.—Appearance of cord inside of normal unopened arachnoid.

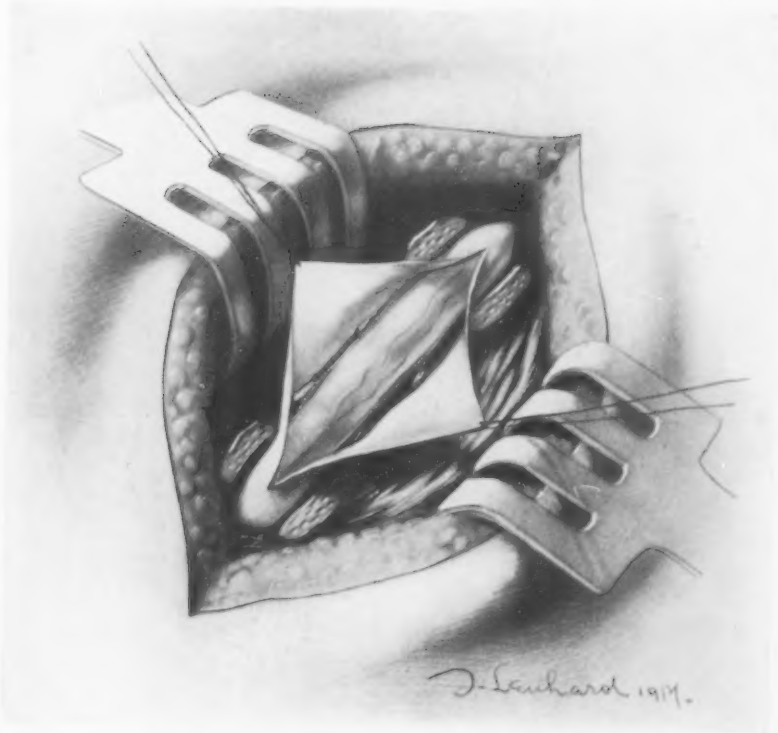

FIG. 5.—Cloudy arachnoid after old trauma of cord.

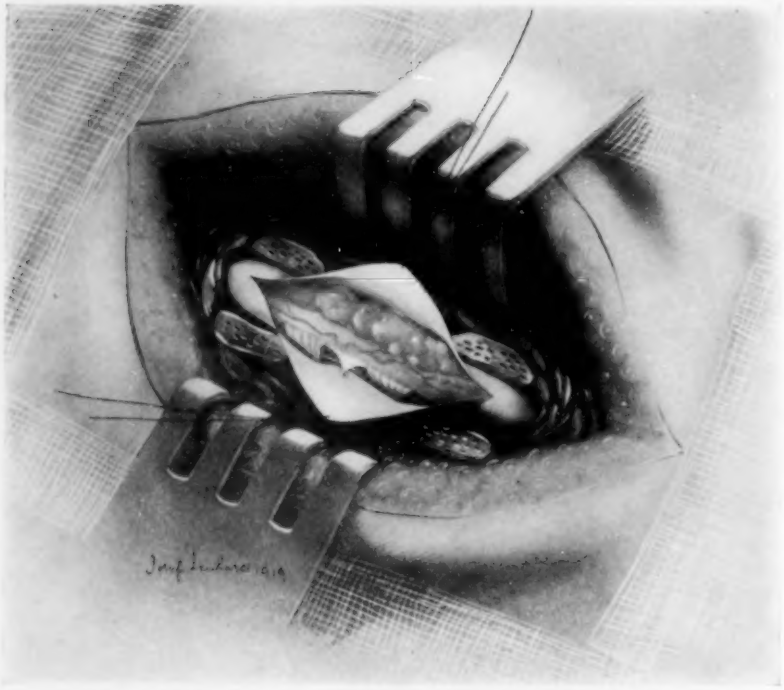

FIG. 6.—J. K. Laminectomy for old fracture of spine. Localized arachnitis with adhesions forming a mass of closed cavities filled with fluid.

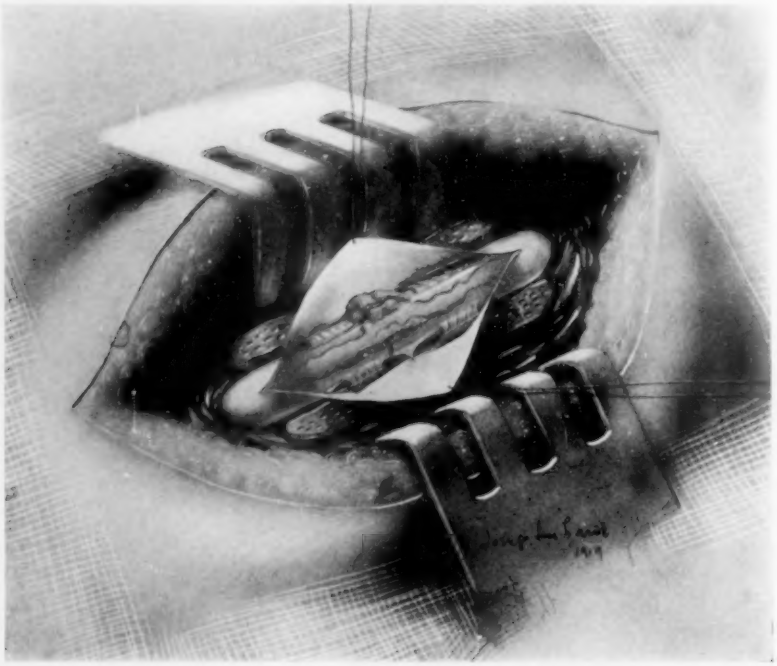

FIG. 7.—T. M. Laminectomy for old fracture of spine. Localized arachnitis with formation of new blood-vessels.

FIG. 8.—Appearance of cord at level of old transverse cord lesion.

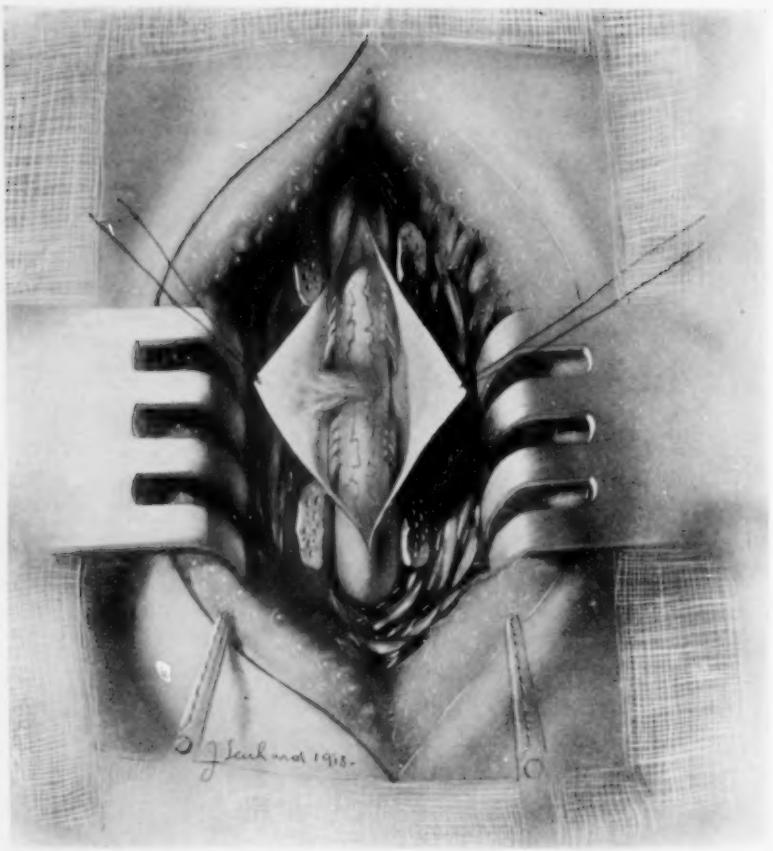

FIG. 9.—Laminectomy for old fracture of spine. Large mass of scar tissue extending from surface of cord to inner surface of dura.

2. *Changes in the Spinal Cord.*—The appearance of the spinal cord months or years after a trauma varies, of course, within wide limits. Surprisingly little macroscopic change may go hand in hand with very severe symptoms and very marked loss of function. Thus a slight increase in the vascularity over a localized area may be the only change in the gross appearance of the cord at the level of the old complete transverse lesion (Fig. 8). The spinal cord may appear normal to the eye in spite of a cavity in the cord filled with fluid (hydromyelia) or a hæmatomyelia. In these conditions, however, the cord often appears larger than normal and its consistency less firm so that the operator can recognize that the cord contains an abnormal amount of fluid. As is well known, cavities in the cord often extend over a large part of the cord, but I have seen the largest cavities in the lower dorsal, lumbar and sacral regions. In some of these patients, drainage of the fluid into the subdural space (subarachnoid) by a carefully made incision into the cord, may result in great benefit to the patient. If the cord tissue has been much thinned by the pressure, the condition is irremediable, as hopeless, in fact, as an advanced hydrocephalus.

When a thick scar is observed on the surface of the cord, it is never possible to say whether we are dealing alone with a surface lesion or whether a large part of the cord itself is involved, but I have seen superficial masses of scar tissue which could be excised without difficulty and without injury to the cord underneath (Figs. 9 and 10). On the other hand, the cicatrix may involve so much of the cord that the excision of the scar tissue would be certain to do more harm than good (Fig. 11). In these patients, the decompressive incisions through the superficial scar tissues above mentioned may relieve some of the pressure upon the cord at the affected level.

Very marked cord symptoms may be caused by distortion or narrowing of the spinal canal by new formed or dislocated bone, either through actual pressure upon the cord or through distortion of the canal and "angulation" of the cord. If the body of one vertebra has been dislocated backwards or if the body of one vertebra has been crushed and as a result the vertebræ above and below have become tilted, the cord may be stretched over a projecting mass of bone and subjected to both pressure and stretching. Very marked cord symptoms may result. We have seen very great improvement follow the removal of the projecting part of the body of a vertebra. A wide decompressive laminectomy allows the cord to bulge backwards and thus overcomes the marked angulation above described. We have seen numerous instances of this type and have seen great improvement follow the operation. Especially excellent results have followed the surgical interference when the lumbo-sacral cord and upper part of the cauda equina were angulated or compressed.

It is obviously unnecessary to advise that a cord compressed by dislocated or new formed bone which has markedly narrowed the spinal

canal, should be freed from the pressure by the removal of as much bone as is necessary.

Up to the present time there is no well supported evidence that the tissues of the cord can regenerate, and it is more than probable that functional regeneration is impossible. Therefore, operations for complete division of the spinal cord should never be attempted.

Lesions of the roots of the cauda equina are often seen as the results of bullet wounds and of fractures of the spine. Some of the roots may be divided and enveloped in scar tissue or the entire cauda equina is surrounded by a mass of scar. In some of these patients the scar tissue can be peeled off of the nerve roots, in others, the connective tissue is so dense and so many of the roots are involved, that the attempt to free the roots would be certain to cause a great deal of injury to roots that are still functionally useful. The surgeon must be very careful, therefore, in an operation of this kind, not to attempt to do too much. Sometimes one can make only decompressive incisions in a longitudinal direction through the scar tissue between the nerve roots. If we were more certain that regeneration of a divided anterior root is always satisfactory, the resection of anterior nerve roots with subsequent nerve suture would be justifiable. Much experimental work is still necessary, however, to place such a procedure on a firm foundation. The procedure may especially be called for in injuries of the nerves of the cauda equina. Everyone seems to be agreed that the ends of a divided caudal nerve root should be sutured together, but the results thus far obtained have been unsatisfactory. I have never seen a satisfactory result from such a suture.

Finally, the subject of the lesions that are met with in old injuries of the cord, should not be dismissed without a short consideration of the question of the indications for treatment.

As opinions are still at great variance, the question, "What symptoms and signs justify operative interference?" is an all-important one.

The neurologist and the surgeon must always keep clearly before them what they can hope to accomplish by an operation for old injury to the spinal cord—whether adhesions which compress the cord or nerve roots are to be divided, an angulation of the cord straightened out, the spinal canal narrowed or deformed by dislocated or new formed bone to be enlarged, thickened dura to be excised, etc. In order to arrive at a proper conclusion, thorough and repeated neurological examinations and good X-ray plates are necessary.

1. Without doubt, surgical relief is impossible if the symptoms of a complete transverse lesion have existed from the time of the trauma even if, after months, reflexes have returned and spasticity is marked.

2. There is no hope of relieving a patient with the symptoms and signs of an incomplete cord lesion who has large bed sores and who is much emaciated. In these individuals, the cord lesion is surely an irremediable one and is often complicated by pyelitis or pyelonephritis.

FIG. 10.—Laminectomy for old fracture of lumbar vertebræ. A mass of scar tissue is compressing a number of the roots of the cauda equina.

FIG. 11.—An irremediable cord lesion after old injury to the spine. The spinal cord is much thinned at the level of the lesion and is adherent to the inner surface of the dura.

I have never seen any useful improvement occur after operative interference, although I often tried to benefit the patient by surgery.

3. Individuals who have, after a spinal trauma, improved considerably for a period of months but in whom the improvement has stopped before useful function of the limbs has been regained, should be operated upon either if a marked angulation of the cord has remained or the X-ray shows a narrowing of the spinal canal by dislocated or new-formed bone, unless the examination shows that there is a dissociated disturbance of superficial sensation. This dissociation is, of course, an evidence that there is an old hæmatomyelia or perhaps a gliosis secondary to an old intramedullary hemorrhage.

4. If there has been considerable return of power in the lower limbs and the condition has become stationary, and if locomotion is interfered with by the spasticity, a laminectomy and division of the appropriate posterior nerve roots—according to the principles laid down by Foerster—is often followed by very satisfactory results.

In my experience, posterior root section for the spasticity of Little's disease has given few good results, no matter how thorough the after treatment. I have, however, seen some very excellent results of rhizotomy in old spasticities which have followed a spinal traumatic lesion and in some of the cases of residual spasticity after the removal of a long existing extramedullary tumor of the spinal cord.

5. Severe root pains at or near the upper level of the lesion, if they can not be relieved by immobilization of the spine by a plaster jacket or other apparatus, may demand operative interference, and the surgical procedure in these patients must consist of a wide decompressive laminectomy with division of the necessary posterior nerve roots. One of the most successful results of operative interference for old spinal fracture that I have ever observed was in a bedridden patient in whom severe motor and sensory disturbances in the lower limbs which remained after a fracture of the spine sustained many years before, were complicated by recurring attacks of root pains referred to the lower dorsal roots. In this patient, a wide decompressive laminectomy with division of the affected nerve roots was followed not only by relief of the pain but by a great improvement in the motor and sensory symptoms, so that the patient was again able to walk about.

6. Can we benefit a patient who has vesical incontinence left after an old spinal injury of the lumbo-sacral cord or cauda equina? This question is a most important one. The individual may have regained complete or almost complete control of his limbs, but his life is made a miserable one by the urinary incontinence. I have recently seen several soldiers who had recovered very satisfactorily from all of their symptoms excepting the bladder paralysis, and it would have been a most happy result if by an intradural root anastomosis, a return of bladder control could have been obtained. Theoretically, regeneration of the anterior nerve roots

should be possible and technically the anastomosis of anterior roots above the lesion and the third and fourth sacral roots (which partly control the bladder musculature *) is not so very difficult. The experiments of Cadwallader and Sweet, of Frazier and Allen, and more especially those of Kilvington, show that such an anastomosis can be successful; up to the present time experiences in man have been inconclusive but the subject is one pregnant with possibilities for the future.

Among the last 200 laminectomies I have performed, 20 operations were done for spinal lesions due to old fractures or wounds of the vertebral column. Of these patients, 8 were completely relieved of their symptoms and 6 were greatly improved. In 6 there was little or no improvement. With increasing experience, still better results should be obtained in the future.

* The bladder receives its nerve supply partly from the somatic and partly from the autonomic systems.

ON THE DIAGNOSIS AND THERAPY OF BONE TYPHOID

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It has been pointed out by various authors who have occupied themselves with the study of typhoid complications in the bone system that the therapy in such cases is far from satisfactory as regards the results.[1] Although no small number of cases of different forms of typhoid bone processes have been published, and the clinical course of this disease studied in considerable detail, yet our knowledge is defective in this respect also. With the increasing use of radiography in diseases of the bone system, such diseases will, no doubt, be more frequently discovered and localized than has hitherto been the case, but from a radiogram one cannot draw any conclusions respecting the determining etiological factor, at least, no conclusions can be arrived at in a large percentage of bone diseases of the focus type.

Typhoid has been very closely studied from the bacteriological and pathologic-anatomical point of view, and the Eberth bacilli are among those bacteria which we have least difficulty in definitely examining. Owing to this circumstance, and to the fact that the risk of a wrong conclusion with reference especially to the paraglutinability of other specific sera is comparatively slight as regards typhoid, I have by means of bacteriological examinations of bacteria obtained from isolated foci succeeded in proving the typhoid nature of the disease when no clinical support for such a diagnosis existed. As localization is interesting and illustrative of the hæmatogen-metastatic propagation, and as, besides, the therapeutic means employed may possibly be of some value, I will here describe the case.

Case I.—The patient, a female, aged eighteen years, was admitted to Serafimer Hospital, November 22, 1917. Her parents and ten brothers and sisters were alive and healthy. She had had measles as a child, *but otherwise has never been ill.* There has been no epidemic of typhoid in her native place. Three years ago she got pains in her right hip-joint, diagnosed by the doctor as rheumatic; she kept to her bed for two months, does not know if she had fever during that time, but had no symptoms from any other organ, and did not feel ill otherwise. Since that time no further trouble from her hip. Some months later, without any external cause, a sore showed itself immediately below the left collar-bone, and spread gradually till it obtained about the size of a child's hand. There was no tenderness and no pain, very inconsiderable secretion from the sore, which, under treatment with

* Read before the Swedish Medical Association, March, 1918.

[1] Murphy, John B., Surgery, Gynecology and Obstetrics, August, 1916.

ointment, healed in about a year's time, leaving a ridgy cicatrix. In December, 1916, consequently six months later, she again got pains in the right hip, and was then admitted to the hospital in her native place. The following is an extract from the journal kept there: " Has latterly had difficulty in supporting herself on the right leg. Large fluctuating area over the right gluteal region. Mobility in hip-joint somewhat restricted, no pain worth mentioning in movement. Radiogram shows a destructive process in the margin of the acetabulum, the caput contour indistinct. Puncture of abscess and injection of iodoform glycerine. Horizontal position. Discharged February, 1917. Diagnosis, coxitis " tbc. dx."

Limped slightly after discharge from hospital. In the beginning of November, 1917, she noticed directly above the right trochanter a red spot, which, after a week's time, began to ulcerate. No pains and but slight secretion. The ulceration spread gradually. At about the same time was observed a redness and induration on the extensor side of the left arm. Admitted to Serafimer Hospital November 22, 1917.

Status præsens on admission: A thin girl, seemingly of weak intellect. Temperature non-febrile, pulse 80, nothing to notice. Nothing abnormal as regards lungs, heart or urine, neither liver nor spleen enlarged. Weight, kilo 41.7.

Local symptoms: Immediately below the medial portion of the left collar-bone a deep-ridged scar, about the size of a florin, with sharply defined rounded edges. In the bone underneath close to the sternum is to be felt a half-moon-shaped defect in the bone of the size of a bean. No tenderness or swelling.

The sternal end of the right collar-bone feels somewhat thickened, but there is absolutely no tenderness.

In the middle of the dorsal side of the over arm can be felt a longitudinal infiltration in the subcutaneous tissues, about 8 cm. long and 3 cm. wide. This, together with the skin, can be pushed against the underlying muscles, and is of fairly firm consistency, but with smaller, softer portions (about as large as the finger-tip) which seem to be defects. The skin in this area is slightly reddish, with a lighter central zone. The whole is perfectly free from any tenderness. Puncture yielded negative result.

Just above the right trochanter major is a surface ulceration, almost circular in form, of the size of a farthing; the edges of the sore are sharp, firm, not protuberant nor undermined. The skin around is reddened, and the bottom of the sore covered with necrotic products. Induration, but no tenderness round the sore. With a probe one comes 7 cm. in towards the hip-joint without anywhere coming upon exposed bone.

Mobility of the hip-joint somewhat restricted in all movements, except the rotatory. No painful limp in walking. No pain in attempted movements of the hip-joint, or in shock palpation longitudinally in the leg. No shortening.

Radiogram same day shows: " Shanton's line unbroken. Articular cartilage of normal height. Lime percentage in caput and collum

femoris less, generally speaking, on the right side than on the left. In the upper part of the collum and in the caput are to be seen scattered rarefied spots. No defined contour alteration in the caput, but the contour lines are not so sharp as on the left side. The radiogram most nearly resembles a conical arthritis without probable alteration in the bone (Forsell).

"The sternal third of the left clavicle is distinctly narrower than the right; the contours are seen; the bone picture does not stand out clearly here; it appears to be thinner than in the other parts. No focus form enlargement; the sternal end seems to be unaltered. The sternal end of the right clavicle shows a rather closely-marked rarefied area of the size of a hazelnut. No periosteal deposits; surrounding bone unaltered (Hansson)."

Wassermann's reaction in the blood negative. The blood serum does not agglutinize typhoid or paratyphoid bacilli.

Blood analysis *H.b.* (Sahli) = 70 per cent.; red blood-corpuscles, 400,000 per millimetre; white blood-corpuscles, 14,000 per millimetre. Differential calculus of 400 cells with Giemsa coloring gave: Neutrophiles, 52 per cent.; eosinophiles, 6 per cent.; basophiles, 1 per cent.; transition forms, 2 per cent.; small lymphocytes, 34 per cent., and large lymphocytes, 5 per cent., equal 39 per cent. lymphocytes. Subcutaneous tuberculine injections in increasing doses with 1, 2, 5 m.g. produced no reaction, either general or local.

As the etiological diagnosis for this multiple bone disintegration and skin infiltration seemed to be absolutely obscure, and as it was evident that no conclusions could be arrived at by means of a culture from the wound in the hip which had been open for a fortnight, a chiselling-up of the right collar-bone was performed on December 7th, and a peculiarly disintegrated bone focus was scraped out; the hole was filled chiefly with granulation tissue, no sequestra. A pathologic-anatomical examination showed only a fibrous transformation of the marrow of the bone in certain parts (Hellman).

The bacteriological examination conducted by Dr. J. Tillgren showed here and there in a direct preparation colored with methylen blue colonies in a granulation tissue poor in cells. In culture on agar a pure culture of the same kind of colonies was obtained; this proved to be gram-negative. The bacilli show no color change from lakmus molke, and no grape-sugar fermentation. In propagation on endo-plates there were colorless colonies.

Agglutination experiments. With serum from typhoid and paratyphoid patients, agglutination in solution 1 to 100, strongest agglutination with typhoid blood.

Repeated examinations of the blood have given negative Widal. The presence of typhoid bacilli in the urine or fæces could not be proved in spite of diligent search. Test excision from the infiltration on the upper arm showed only fibrously altered fatty tissue.

December 18th, condition unchanged. Operation wound healing *per primam*. Infiltration on the upper arm same as on admission. Radiography of both upper arms.

"In the right shoulder joint is to be seen within the humeri-epiphyseal area, and in the adjacent part of the diaphysis an elevation of the bone due to a periostic deposit. In the epiphyseal area a couple of focus-form bone disintegrations. In left caput humeri a rarefaction of the bone structure in the entere caput, with limit towards diaphysis rather sharply defined. In lateral portion of epiphyseal area appears a clearly marked rarefaction of the bone, possibly a bone abscess (Foessel and Ström)."

Carrel drainage with Dakin's solution was applied to the fistula on the hip-joint for six days.

From the cultures obtained from the operation Doctor Tillgren prepared a vaccine by killing the bacteria with +58° C. for half an hour and sitting up in ½ per cent. carbolic acid. Vaccine treatment was begun December 18th with subcutaneous injections and a beginning dose of 25,000,000 gradually increased to a dose of 5 milliards (5 c.c.). No reaction on the patient's part, and no discomfort after the injections.

January 14, 1918. General condition considerably improved. Weight increased by 4.2 kilos.

Wound and fistula in the trochanter region healed. Patient now walks without limping. Mobility in hip-joint unrestricted. Infiltration on upper arm has disappeared.

January 26, 1918. Radiogram shows bone alterations as before, except in the scraped out clavicle focus, which has now the appearance of a well-defined bone defect of the size of a pea. Culture of typhoid bacillus in the blood yielded a negative result.

February 16, 1918. The patient's serum agglutinizes her own bacteria as well as other typhoid bacilli in dilution (one to two hundred). As the virulence of the bacilli seemed remarkably low in experiments on guinea-pigs (the animals surviving after an intraperitoneal injection of 1 c.cm. bacterial vaccine, which was calculated to be three times the lethal strength for ordinary typhoid bacilli), it was decided to seek to raise the virulence of the bacteria through the passages of the animals, and thereafter to prepare a new vaccine. This was done, and after passage through five guinea-pigs, a culture was obtained with lethal effect upon guinea-pigs after twenty-four hours, given in above-mentioned dose. A vaccine was now prepared from this stock, and after a cautious experiment with a small subcutaneous dose of the new vaccine, this was administered in increasing quantities every second day up to 5,000,000,000, which dose was repeated four times in succession.

The patient was discharged May 19, 1918, completely free of symptoms, with positive Widal. An examination in November, 1918, shows nothing noteworthy in her condition.

COMMENT

We have here an exquisite chronically continued pyæmic infection with foci in the bone, joints and subcutaneous tissues. Clinically, all data for etiology are lacking, the patient has never had an illness before, and especially has never suffered from any serious febrile illness. To the theory of tuberculosis

were opposed the following circumstances: Localization, absence of tubercular alterations of other organs, the completely non-febrile course of the illness, (the tendency of the coxitis) to relapse without restriction of the mobility of the joints; partly also the negative result of tubercular experiments, and, finally, the X-ray showings, in which, in spite of the protracted duration of the illness, no calcification, or only very slight, could be discovered. The appearance of the cicatrix under the left clavicle, and the sore at the trochanter suggested a luxation. A hereditary luxation was improbable, as the parents are both healthy, and have ten other healthy children; an acquired one was also unlikely in a sixteen-year-old virgo with negative Wassermann. The radiograms did not favor such a diagnosis either (absence of periostitis or bone sclerosis). The normal blood scheme was against leucæmia, myelomitis or other diseases of the system. The most likely assumption was that of a chronic septic staphylococcic-osteomyelitis with unusually weakened virus, but even on this assumption it was remarkable that the temperature was absolutely normal, and that there was complete absence of tenderness and of reactive processes in the bone from the periosteum, and in the immediate environment of the foci.

The course of the disease, as well as all the clinical characteristics, were most in accordance with a diagnosis of typhoid in the bone system, so we at once took Widal, and sought in the anamnesis after some previous illness which could be explained as typhoid. As both these hypotheses gave negative results, the only possibility left was to seek to throw light on the etiology by means of a bacteriological investigation from another closed focus.

This investigation has shown that we probably have to do with a bacillus of the typhus-coli group. The circumstances against the coli assumption are the manner of growth on endo-plates with glucose-agar and lakmus molke, and, with a certain reservation, the agglutinability for typhoid serum.

Putting together the clinical course, the bacteriological result, the pathologic-anatomical alterations, and the X-ray showings, it may be regarded as proved that we have here a case of typhus or possibly paratyphus chronic pyæmia. The fact that the patient had no knowledge of any preceding typhoid need not constitute any objection, for, as is well known, this disease, especially in childhood, can often have a quite untypical course, while cases of so-called bacillus carriers who have never, in the clinical sense, been ill of typhoid, are already well known. That this patient should be dangerous as a bacillus carrier in the ordinary sense may be regarded as quite out of the question, for, in spite of repeated examinations during a protracted period, no typhoid bacilli could be found in fæces or urine.

There are also instances of exactly reversed conditions. Thus Kasper[1] in 1913 reported a case of typhoid periostitis in the tibia; in this case the typhoid had occurred eight years earlier, and the pus contained Eberth's bacilli in pure culture. Widal was positive in this case, and typhoid bacilli were

[1] Kasper, Fritz., Mitteilungen aus der Grenzgebiet, 1913, h. 5.

found both in the blood and the fæces. This case is explained as being an auto-reinfection in a bacillus carrier, without any abdominal disease symptoms.

Osteitis of the above type with multiple foci has been already described many times. It appears from literature, however, that only 4 per cent. of the typhus-osteitis have occurred in the multiple manner. As shown in the above case, the greater number of the foci exhibited no symptoms whatever, but were discovered almost by chance, in the course of a systematic Röntgen skeleton examination. As such an examination had never been conducted before in similar cases, it may very well be possible that the foci described as isolated have had other foci, and that thus the multiple localization is considerably more common than is generally supposed. This appears probable also from the point of view that the foci are to be regarded as the result of pyæmic metastization. The significance of the multiplicity in localization lies in the fact that it appears to call for a different therapy from that employed for isolated foci, which are easily accessible to direct surgical treatment—consisting of chiselling up and scraping out; and, further, because it seems well worth while in such cases of extended dissemination of infection to make an experiment with vaccine therapy, or, possibly sero-therapy in order to find out the value of these methods. It is well known that bacteria can remain long completely latent, and subsequently show symptoms. Thus Buschke relates a case in which he found a pure culture of typhus bacilli occur years after the patient had had typhoid. Fogh, twenty-three years after, and other investigators record cases of the persistence of typhus bacilli in bone six, seven, ten, thirteen, even fifteen years after the illness. The greater majority of typhoid bone complications show symptoms months or even years after the acute infection has ceased, although not so few cases have been known to occur also during the period of fever or convalescence.

It is evident from the literature on the subject that the type of the acute infection which the patient has passed through does not play any important part in the occurrence of subsequent bone complications. Murphy calculates that in 48 per cent. of the cases the primary infection is slight, or moderately severe, and in 42 per cent. severe. To this may be added those cases in which no intestinal or general symptoms have been observed, and those cases of chronic bacillus carriers in which the individual has never shown any symptom of typhus abdominalis; which shows that purely abortive cases can also produce hæmatogenous metastization.

As regards the frequency of bone complications in typhoid, Murphy has found 164 cases in 18,840 cases of typhoid collected from different authors—thus less than 1 per cent. Funcke found in 700 osteomyelitis cases only 3 with Eberth's bacillus as cause. It has, however, been pointed out that the typhus osteitis cases are probably considerably commoner, though they are often overlooked on account of the insignificance of the clinical symptoms, and also because many such cases in all probability heal spontaneously, or pass into a state of chronic latency. This view finds, above all, support in the observations of many years' latency mentioned above, and also in the case here described with objectively proved foci containing typhoid bacilli in

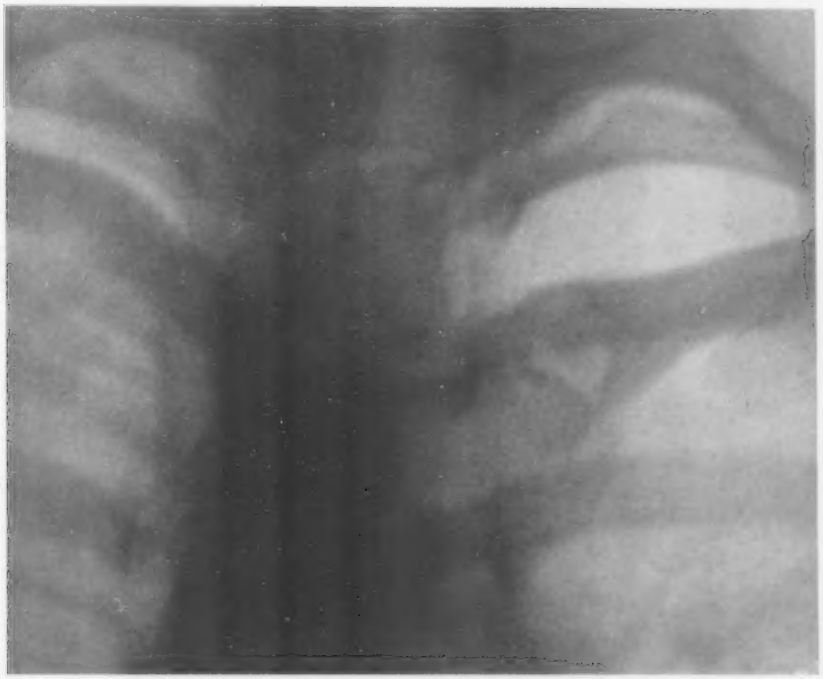

FIG. 1.—Radiogram showing the forms in right clavicle.

FIG. 2.—Left humerus before the vaccin-therapy.

FIG. 3.—Left humerus, the autovaaccin-therapy ended.

FIG. 4.—Right humerus, before the therapy.

FIG. 5.—Right humerus after the therapy.

pure culture, but without any clinical symptom whatever. The lengthy course of the illness, with manifestations occurring here and there in the subcutaneous tissues, would also seem to indicate that the disease was not in complete latency, but possibly, in conjunction with traumata or infections may be regarded as receiving new propagation, and from an eventual primary focus spreading to the blood-vessels, especially when the negative result of Widal's reaction shows the absence of anticorpuscles, or, at least, of agglutins in the blood. The quality of this blood in the case in question seems to me to indicate the existence of one or several closed foci which have not stood in continuous connection with the blood.

A circumstance which also seems to indicate that it has rather been a question of chronic pyæmic typhoid than of auto-re-infection by typhoid bacillus carriers is that Widal's reaction, which on admission was negative, became positive under vaccine treatment. It would appear from this that virus which was of remarkably low virulence, as shown by experiments on animals, did not, however, exist in the body so extensively, or in such open connection with the blood that it could stimulate to the formation of antigen when the capacity of the body to do this was evidently quite unaltered.

The result of the treatment with autogene vaccine is of great interest. Similar experiments have been previously made with chronic bacillus carriers, but with negative result. The conditions are not, however, analogous, because in such cases there has been a bacteria culture in the gall itself, and the bacilli have not there come in direct contact with the anticorpuscles of the blood. From the purely theoretic point of view it was rather to be assumed that the bacteria in the bone foci which had arisen from hæmatogenous propagation could be more immediately influenced by a directly intended antigen formation.

It would be too daring to draw any definite conclusions from this single case, but I have wished the experiments to be more generally known, especially with reference to my previously expressed opinion that multiple typhus foci in the bone system are much commoner than has been hitherto believed, and that therapy, in such cases, must not be satisfied with a simple intervention in that focus which, for the time, shows symptoms, but ought, as far as possible, to strive to render harmless the bacteria wherever they can be localized. Nothing but continued experiment in this direction can decide the value of the method of treatment here proposed, but that this treatment has had a favorable effect upon the disease is indicated by the fact of the rapid healing of the fistula in the trochanter region, compared with the period of over a year which the fistula (also of spontaneous origin) under the clavicle required for healing; further, the return of mobility in the hip-joint, as well as the disappearance of lameness, the resorption of infiltration in the subcutis of the over arm, and finally, the very considerable improvement in the patient's general condition.

The objective proof that the vaccination took effect upon the organism is furnished by the fact that Widal's reaction became positive after the injections. The other bone alterations have shown no subsequent symptoms,

and Röntgen examination has not been able to prove the existence of any progressive destruction, nor the appearance of any new foci.

Vaccination is employed prophylactically to a considerable extent against typhus and with excellent results. Attempts have been made with curative aim to make use of partly convalescent serum, partly dead culture in cases of abdominal typhoid at its acute stage, but as is natural to expect, it is singularly difficult to judge of the results, although most authors believe themselves to have obtained favorable effects from this treatment. The figures vary in the different statistics—in some cases vaccine therapy is believed to have been directly instrumental in saving life, in others no effect whatever can be proved.

As regards the possibility of judging of the results of vaccine therapy, it may be stated with certainty that this is considerably more difficult during the acute stage than in post-typhoid complications. In the latter it can happen, as was the case here, that anticorpuscles no longer existed, or at least, their presence in the blood could not be proved with the usual reactions; artificial antigen formation can, therefore, theoretically, be considered to have greater likelihood to exert influence upon the disease.

Brekke has, in 1916, given an account of extensive experiments in the technic and application of different serological methods of showing the existence of typhoid anticorpuscles.

He examined sera from normal individuals, from typhoid patients, and from persons vaccinated for typhoid. He has found that the quantity of bactericidal amboceptera in a normal serum is very small, also that the agglutinizing capacity of normal serum is very inconsiderable. In general, the presence of agglutinization could not be proved in a dilution of 1 in 40, which the author considers to be the top limit for the agglutinative capacity of normal serum.

In typhoid patients, on the other hand, could be observed a considerable production of amboceptera; the maximum quantity of amboceptera existed at the close of the febrile stage. After this the quantity diminished. The curve of agglutination showed itself more irregular, although the agglutination production seemed to take place chiefly during the fever stage. There was no distinct correspondence between the course of the two curves; Brekke gives it as his opinion, however, that the production of the two substances does not appear to take place absolutely without connection. In a high proportion of amboceptera he found a constant higher agglutinability. The complementary curve appears to be independent of the course of the disease.

No distinct relation could be proved to exist between the clinical picture of the disease, its severer or milder course, etc., and the quantity of anticorpuscles. Even three years after the illness the percentage of amboceptera is higher than normal; the agglutinations diminish much more rapidly.

After vaccination for typhoid the formation of anticorpuscles increases also to the highest degree after two injections. The number of these specific anticorpuscles is, in vaccination, in some cases as great as in the disease itself, but, as a rule, it is somewhat less. During the whole of the first year after

vaccination the quantity of both amboceptera and agglutinins is higher than normal.

Brekke's experiments show, therefore, that the conditions in serum during the illness and during vaccination are absolutely parallel and qualitatively identical, even though differences possibly exist quantitatively.

It is of interest in this case that when the patient had not had any clinical typhoid, and on admission still gives negative Widal, even in low dilutions, in spite of multiple foci that the serological vaccination result is agglutination formation which can be proved by the patient's own bacteria in dilution, as these agglutinize by convalescent serum. Brekke has shown that amboceptera production as a rule accompanies agglutination production; it does not, therefore, seem to be a rash conclusion to draw from the result of the treatment in this case that anticorpuscles are developed during vaccination, and that one can therefore hope that the other foci can, by this means, be hindered in their further development. The fact that agglutinations are formed seems to me to favor the idea that the bacteria were originally of very low virulence, otherwise one ought to have expected a previous agglutination formation. That such an antigen formation can take place by reinfection is apparent from Kasper's case, the result of the treatment here tried seems also in favor of this, for it would be difficult to imagine a bacterial hæmatogenous propagation such as exists here, unless the formation of anticorpuscles at least during the transport should have been in some measure stimulated. That continuous propagation took place cannot be proved, but this seems probable from the relatively rapid occurrence of subcutaneous infiltration.

CONCLUSIONS

1. Multiple typhoid bone foci are probably commoner than is shown by statistics.

2. A condition of disease can occur even when no clinical typhoid record of disease can be found; the course of the primary disease is without significance for the appearance of bone metastasis.

3. It is not necessary that Widal's reaction should give positive result, even if multiple foci exist.

4. Systematic Röntgen examination is desirable for the entire skeleton in isolated bone foci, in order to determine the treatment.

5. The diagnosis can be made with certainty only by means of bacteriological examination of the foci discovered. Radiographs show nothing specific, only the existence and localization of foci.

6. The single foci are quickly and securely accessible for direct operative treatment.

7. Vaccination therapy has, theoretically, the possibility of hindering the further development of bacteria, at least in those cases where Widal's reaction is negative.

8. Autogenous therapy has been tried in one case without discomfort to the patient, and with apparently good results. There seems to be good reason for continued experiments in this direction.

DIAPHRAGMATIC HERNIA

ITS UNSUSPECTED FREQUENCY: ITS DIAGNOSIS: TECHNIC FOR RADICAL CURE

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It is the purpose of this paper to call the attention of internists and of surgeons to the frequency of diaphragmatic hernias, especially small ones, because patients suffering from this condition are not properly treated, for the reason that the correct diagnosis is not made, and therefore the treatment is based on curing pathological conditions which do not exist, or co-exist with the diaphragmatic hernia, and the result of the treatment must be, at least, absolutely negative. If diagnosis of diaphragmatic hernia, when a great portion of the stomach, or all the stomach and several loops of intestine have emigrated in the thoracic cavity is made positive, at the present time, with the help of the X-rays, we believe that the diagnosis of small diaphragmatic hernias, which, we repeat, are more frequent than it is commonly thought, and give rise to very serious troubles, has never been made before operation or autopsy. We insist on the frequency and importance of small, very small, diaphragmatic hernias, because unfortunately the subject has received little attention by the internist and the surgeon. This lack of interest is not easily explained, because diaphragmatic hernias give rise to so many complicated and serious symptoms, which if not properly attended to, will lead the patient to an unfortunate life and premature death. That little attention has been paid to the subject of diaphragmatic hernia is proved by the fact that text books, even the ones devoted exclusively to diseases or surgery of the abdomen, either do not even mention the subject of diaphragmatic hernia, or devote only few lines to it. Yet diaphragmatic hernia is a condition requiring immediate surgical intervention, if the patient is to be cured and his life preserved. In fact, if the diagnosis was made at the very beginning, neither congenital nor traumatic or acquired diaphragmatic hernias would cause long useless suffering and later endanger the patient's life, on account of the actual and probable troubles caused by the herniated organs, and the difficulty or even impossibility of performing later a surgical operation, that should cure the patient. Because we have not to forget that at the beginning either a congenital or acquired diaphragmatic hernia is in practically all cases easily operated, while later the mass of the herniated organs increases and might not only be strangulated, but acquire adhesions with the thoracic organs which might render a radical cure difficult or even impossible.

The rather small number of cases of diaphragmatic hernias on record

is not due to their rarity, but to the fact that autopsies are made only on a very small percentage of cases and many patients who might have, and certainly have, died, on account of the presence of a diaphragmatic hernia, have been put on record as deceased not on account of the real disease, but on account of some other pathological condition, because the diagnosis of diaphragmatic hernia had not been made *in vivo*, and the autopsy has not been performed; and even the operating table fails to reveal the presence of diaphragmatic hernias, either because, as our cases will prove, the hernia is not thought of and therefore no operation is performed, or because the diaphragm is not properly inspected: the few small and even large diaphragmatic hernias operated, were not operated because the correct diagnosis had been made, but only because the diaphragmatic hernia was discovered on the operating table, to which the patient had been brought for some other supposed pathological condition: let us not forget the fact, that the diaphragmatic hernia was discovered perhaps only because, on examination of the different organs, they were found all absolutely normal and a very careful search made for the discovery of the cause of the pathological symptoms on account of which the operation was undertaken, revealed accidentally the presence of an opening in the diaphragm; if any pathological condition had been found, that would even most incompletely explain the pathological symptoms, very likely the opening in the diaphragm would have been overlooked and the patient would have had an operation that might have been not only useless, but dangerous. In fact, how many surgeons do inspect the diaphragm when they open the abdomen? I believe very few, exceedingly few, if any, and the writer acknowledges that he himself had never carefully and systematically examined the diaphragm, before he had the opportunity and good luck of observing the cases that will be related later and that convinced him of the unsuspected frequency of diaphragmatic hernias and of the absolute necessity of its diagnosis.

It is obvious, that it is absolutely indispensable to make the correct diagnosis, when even the smallest diaphragmatic hernia is present, in order to treat properly the patient, and not do him harm, as it is done when the diagnosis is not made, as was done in two of our cases. Why is diagnosis of diaphragmatic hernia so seldom made? We believe that two are the main reasons, why diaphragmatic hernias, especially the small ones, are seldom diagnosed: the condition is thought to be very rare; there is not a symptomatology peculiar to diaphragmatic hernias except in the cases of large ones. Let us take up these two points: frequency of diaphragmatic hernia and its symptomatology. That diaphragmatic hernias are much more frequent, than they are thought to be, there is no doubt in our mind about this point, but the internist and the surgeon must think of the possibility of the existence of a small diaphragmatic hernia in all cases suffering from obscure abdominal symptoms, as they think of the possible presence of ulcers, adhesions, kinks,

etc., in order to find more often, than at the present time, that a diaphragmatic hernia is the main or an accessory cause of the troubles complained of by the patients. For the surgeon especially it is very important to think of the possibility of the presence of small diaphragmatic hernias and therefore explore carefully and systematically the diaphragm, in all the cases in which a laparotomy is performed, as he explores all the abdominal organs, *and the diaphragm should be carefully explored also, when other pathological conditions are found, that might explain the symptoms that brought the patient to the surgeon, because of the possible co-existence of diaphragmatic hernias with any other pathological condition,* as will be seen in our cases. We do not insist on this point, because it is too obvious that the patient with a diaphragmatic hernia would not be cured, if the diaphragmatic hernia is not first diagnosed and then properly treated.

Symptomatology.—We have stated that small diaphragmatic hernias are not diagnosed, because they have not a symptomatology of their own: perhaps it would be more correct to state, that we do not know yet a symptomatology peculiar to small diaphragmatic hernias, because not having been diagnosed as pathological entities, the data relating to them have not been properly recorded and collected. When we shall get the habit of thinking of the possibility of the presence of small diaphragmatic hernias, we shall be able to make up a symptomatology peculiar to them, that will lead us to the correct diagnosis, as it happens now in other pathological conditions, that in past years were not diagnosed, because their existence was not known or they were thought to be rare, and in order to make this idea clear, we shall only mention ulcer of the duodenum and appendicitis, the diagnosis of which is made with accuracy at the present time, that we are accustomed to think of their existence and have collected and recorded many important data about them, while in past years, and not many years ago, their diagnosis would have been impossible or exceedingly difficult, and therefore was seldom made. The symptomatology of diaphragmatic hernia is quite complex, because it depends on many factors: the point where the continuity of the diaphragm is broken, the organs that pass through the opening from the abdominal into the thoracic cavity: the portions of these same organs; the relations or adhesions that these organs might contract between the various organs passing through the diaphragm or the organs situated in the thorax, or with the diaphragm itself: the permanence of the herniated organs above the diaphragm: the compression that the diaphragmatic opening might make on the organs herniated: the pulling of the herniated organs on the portions of the same organs that remain in the abdomen: the disturbs that the herniated organs might cause to each single thoracic organ, or to some of them, disturbs which vary according to the position of the patient, that is, whether he is standing or lying down, or on the back, or on the abdomen, or on the left or right

side; to his taking drinks or food, either liquid or solid, cold or warm, to his work, to his emotions, to his temperament. It is sufficient to think of how a diaphragmatic hernia would affect a dispeptic or neurasthenic patient, according to the conditions mentioned above, to make it clear, that it is impossible to fix at the present time a symptomatology peculiar to the existence of a small diaphragmatic hernia. We use intentionally the expression small diaphragmatic hernia, because the large ones are easily diagnosed, when their existence is suspected, by the classical signs of tympanism in the thorax and with the X-rays, and because the small ones are the very ones which give rise to serious troubles, which are wrongly diagnosed and therefore not properly treated, and which are not diagnosed yet even with the help of the X-rays. In fact, while the X-rays are making the diagnosis of large diaphragmatic hernias very plain and easy, they have not given any help in some cases of small ones; on the contrary, they have even lead to a wrong diagnosis, by their supposed and apparent negative findings. Indeed, a small opening in the diaphragm through which a very small portion of the stomach might pass, cannot be diagnosed always with the X-rays, because, when the barium meal fills the stomach, no barium might have entered the herniated portion, or the portion itself at that moment was not herniated, and even the air bulb might not show any appreciable change, or as it has happened, the barium filled portion is mistaken for a diverticulum of the œsophagus. So we can state that the diagnosis of small diaphragmatic hernias can give rise to a complex of symptoms, which at this time cannot be properly classified, because the cases on record are few, and which depend on the conditions we have mentioned above; that not even the X-ray can confirm or deny the existence of small diaphragmatic hernias; that at the present time the proper conduct to follow in regard to diaphragmatic hernia, is to think more of the possibility of its existence, alone or associated with other pathological conditions, and to think of it especially in obscure abdominal cases, where repeated examinations of the different organs and their secretions fail to reveal any conditions that can explain the symptoms complained of by the patient: that the surgeon should examine systematically and carefully the diaphragm in every case in which he performs a laparotomy, especially when he operates on patients with symptoms which are not completely explained with the pathological condition, which he thinks called for operative intervention. These symptoms are quite complex and can go from a feeling of heartburn that disturbs the digestion, to symptoms related to the heart, to the lungs or both, to the difficulty in taking long breaths, to occasional vomiting, to vomiting occurring after every meal, or only after taking certain kinds of food, or taking either hot or cold drinks; to the most severe symptoms on the part of the stomach, especially when adhesions between the stomach and the opening in the diaphragm take place, or when the stomach is pinched or strangulated by the diaphragmatic open-

ing, to difficulty in swallowing, and to many other disturbs that might arise on account of a special hernia and of the temperament, habits, profession, emotion, age, sex of the patient. How could anyone outline the symptomatology of a small diaphragmatic hernia in a nervous pregnant woman, for instance? We only present the problems arising from all these conditions, because in order to discuss them competently, one should have had the occasion of studying a great number of patients with diaphragmatic hernias; we must and shall feel satisfied, if we have stimulated the medical profession to a more thorough study of the subject and have contributed to develop a rational technic for the complete treatment of diaphragmatic hernia.

That the subject of diaphragmatic hernia is worth of any attention the medical profession might pay to it, is proved by the cases which we report, which although few in number, show clearly that the diagnosis of diaphragmatic hernia would have prevented a useless operation in two cases and in all three it was essential in saving the patient's life.

Case I.—Miss M. E., aged nineteen, girl poorly developed and rather anæmic. Her history is one of long suffering; dismenorrhœa, constipation, indigestion and severe pain in the abdomen, the nature of which the girl cannot explain better than by saying that she suffers every time she has her menses, that she had once a very severe pain in the right side of her lower abdomen, that she had for a long time a dull pain over there, that she suffers from indigestion and constipation, that at times she can not breathe, that she feels like crying all the time; in fact, she is a rather neurotic subject, discouraged and very melancholic. A year previously she finally submitted to an operation, because of the pain in the stomach and in the lower abdomen, of difficulty in digestion, and occasional vomiting. It seems from the account obtained, that the surgeon did not find anything else but a right ovarian cyst, which was removed and thought to be the cause of all the patient's troubles. For a few weeks after the operation the patient felt better and was greatly encouraged, because her menses were twice much less painful than previously. When she began to try to live a normal life, she felt the same troubles she was suffering before the operation; grew terribly discouraged, because all the doctors she consulted stated that there was nothing the matter with her stomach, that she was nervous and so forth, all putting the cause of her troubles on the nervousness and constipation. When seen by the writer she complained specially of pain in the lower abdomen and pain all over her chest and stomach. Repeated examinations with the X-rays and test meals failed to reveal any pathological condition of the digestive tract, but a certain delay in the emptying of the stomach, and her troubles were attributed by the writer to adhesions that might have formed on the abdominal organs following the operation, and to an exaggerated sensibility and nervousness. We did

not advise another operation, thinking that it would be better to have the girl sent to the country and try to build her up and improve her general condition. The advice was followed and as no improvement was noted, the girl insisted on being operated again and see what was the matter with her. On opening the abdomen along the former incision we noted that there were quite a few adhesions present, the omentum was adherent to the abdominal wall and the right adnexa, the stomach had here and there some very slight adhesions with the abdominal wall; we freed all the organs in which adhesions were found and could find nothing abnormal in any of the abdominal organs. After having freed the anterior surface of the stomach from very slight adhesions easily dissected, we noticed, however, that the small curvature did not come in full view and we thought that there might be some adhesions higher up, in reality the stomach seemed to be adherent to the diaphragm and in trying to free it, we felt that our finger did not meet any resistance and had entered a cavity; at first we feared to have been in the presence of a stomach wall thinned by some pathological process and that we had broken with our fingers, so we gave the patient a slight Trendelenburg and saw instead, that there was a gap in the diaphragm around the œsophagus on the left side. The gap was about three centimetres in length, the stomach was adherent to the edge opposite the œsophagus, and the whole diaphragm appeared rather thinned. The stomach was freed and the gap closed following the technic we shall explain below. The after-treatment was directed to build up the patient and improve the conditions of her bowels. An X-ray examination showed that there was a ptosis of the stomach as shown in Fig. 1. We advised, therefore, the wearing of an abdominal belt, paraffine oil, abdominal massage, and active country life for a long time. At the present writing the conditions of the girl are most excellent, the stomach falls still two fingers' breath below the umbilicus, but that does not seem to affect at all her health and the function of the stomach.

Case II.—R. G., infantry soldier, had been wounded on the Carso about three months previously to the time he was admitted to our service at the Military Hospital in Vercelli. Nothing worth of notice in the past history. The present history, given war condition, was very scanty, the patient said to have been very ill, and unconscious for several days; he was not operated upon, but kept absolutely still. On examination he showed two wounds, one about two centimetres long on the right of the umbilicus, and another smaller and of irregular form between the eighth and ninth ribs along the scapular line. The wound of the abdomen was healed and showed a scar of irregular form, the one on the back was covered by a scab and was adherent to the eighth rib; the scar on the abdomen was rather painful. The patient complained of difficulty in breathing, of pain all over the abdomen and chest upon any physical exercise or even turning around in the bed, difficulty of digestion and occasional vomiting and constipation. We could not

ascertain whether we had to deal with a patient who had been wounded by one or two bullets; from the appearance of the scars it would have seemed that only one bullet had struck the patient, the bullet entering through the chest and coming out from the abdomen; but war experience has taught us that it is not such an easy matter to determine these facts with accuracy. However, on physical examination and from the few lines of history written on the patient's card, it could be established that the patient had certainly suffered from a severe pleuritis and that drainage of the pleura had been continued for about forty days, a piece of cloth having been extracted from the wound and that the wound of the abdomen had also been drained for several days. As we could not find any bullet or piece of shell, we thought that the wounding agent had been single and had passed from the thorax into the abdomen, and on the basis of the pictures obtained, the one we publish being the most typical, and from numerous X-rays examinations made under the screen, we thought we had to deal with a case of hernia of the small intestine into the lesser peritoneal cavity with probable perforation of the stomach and small intestine, resulting in a stomach being formed between these two organs on the posterior surface of the stomach; we held this opinion, for the fact that the vomiting contained a great quantity of bile, although the only stomach content that we could obtain with the stomach tube did not show any bile; we could not examine repeatedly, as we would have liked to do, the stomach content, because the patient stated that he could not stand the swallowing of the tube, and indeed, we had to discontinue using it, because the patient did really suffer from its use; and we thought that, anyhow, our reasoning was logic and congratulated ourselves on the beautiful and accurate diagnosis we had made. On operation, however, conditions were found to be quite different; there were strong adhesions between the wound, the omentum, the colon and some coils of the small intestine, there were adhesions between the coils of the jejunum, some coils of which were really found in the lesser peritoneal cavity adherent to the posterior surface of the stomach, but without any communication between them; the upper pole of the stomach was adherent to the diaphragm and a portion of it closed a gap in the diaphragm of about three centimetres. All the organs were freed, and the diaphragm closed with the technic we shall explain below. The patient left the hospital in good condition and able to eat and digest easily the ordinary soldier's food, still complaining of slight pain in the thorax and some difficulty in breathing, which naturally can be explained with the wound of the thorax and the following pleuritis.

Case III.—G. A., infantry soldier, aged twenty-one, nothing in past history, wounded on November 18, 1917, at the left of the xiphoid, no exit of the wounding agent. Patient lost consciousness immediately and was unconscious for about thirty hours: remembers that on regaining consciousness he was loosing great quantities of

blood from the mouth and from the wound, and had continuously the impression of choking, which impression was increased while he had coughing spells, which would bring out more blood from the mouth. Around midnight of the nineteenth he had a more severe spell of coughing and had the impression of being completely choked by something pressing on the inside of his chest and abdomen; he vomited then the food that he had eaten the morning before being wounded, that is, about thirty-eight hours after the food had been eaten. The effort made him faint and when he regained consciousness in the morning he was told that during the night he had been given several injections (probably saline hypodermoclysis and camphorated oil). He began to feel somewhat better, kept loosing blood from the mouth for five days more, and from the wound, which was packed with gauze, for about ten days. The sputum then was mixed with blood for about ten days, and the wound secreted bloody pus. The patient was transferred to a base hospital when the wound healed; was examined with the X-rays, nothing abnormal was found and the patient discharged with a leave of convalescence on the 23rd of December. The patient went home, very weak and pale and kept an almost complete milk diet, because if he ate any solid food he would have feelings of indigestion and heart oppression, relieved only by vomiting. During his stay at home the patient had temperature up to 39.6 so that he went back to the military hospital and the fever continued until about the end of January, 1918. Patient was without fever for two weeks and then had again temperature up to 39 for about 20 days more. He always complained of pain in the abdomen, indigestion, some constipation, some painful cough, and especially of pain around the heart: the pain was so severe, that mustard plasters were applied to the chest over the heart and seemed to have given some relief; the diagnosis made was bronchitis and pleuritis. The patient failing to improve was sent in April to the observation hospital in Milano, where he was thoroughly studied by competent physicians who submitted the patient to the X-rays, which revealed the presence of a small fragment of shell in the upper left region of the abdomen, postums of severe pleuritis and slight dilatation of the heart with cardiopalmus. The patient was given again a convalescence leave of three months, but he returned to the hospital before his furlough was ended, because he could not eat anything solid without vomiting and was loosing flesh and strength, and complained even more than at any previous time of pain in the heart region and inability of doing even the slightest physical exercise. The patient was told that he was too nervous and was advised to take a complete rest, resort to milk diet exclusively and live in the country: he refused to accept the advice, insisting on being admitted to the hospital and undergoing a surgical operation for the removal of the fragment of shell (which he thought was causing all his troubles). He was admitted again to the hospital and in July sent to the surgical division. There the patient was kept several

days and thoroughly examined. The X-rays revealed the presence of a fragment of shell in the upper left side of the abdomen and some abnormalities in the shape of the stomach; so at the end of July the patient was operated by a very competent surgeon, who removed the small fragment of shell of the size and form of a grain of Indian corn, situated between newly formed adhesions behind the small curvature of the stomach, and freed the stomach, which then showed itself quite dilated, from a newly formed band that divided it practically in two halves. The patient failed to get any benefit from the operation, and the physicians in charge in consultation with others, thought that the extreme nervousness and excitability of the patient and probably a paresis of the stomach, due to the wide dilatation found at the operation, were the causes of the present precarious conditions of the patient and though it advisable to perform a gastro-enterostomy, as a drainage operation. The patient having consented to have anything done that would relieve him, it was decided to perform the gastro-enterostomy. The writer saw the patient ready for the operation of gastro-enterostomy in the first Surgical Division of the Ospedale Militare Principale of Milano, while he was substituting the chief of the service Professor Mariotti, to whom he wishes to express his gratitude for having given him all the opportunities to study the case and allowed him to operate on the same, with his invaluable help and assistance.

Before the operation the patient was in exceedingly poor condition, terribly excitable and nervous, and practically a living skeleton. Repeated X-ray examintaions made by the writer showed the conditions demonstrated in Fig. 3, and at the operation the condition of the abdominal organs were such as the ones reproduced in the drawings represented in Figs. 4 and 5. The portion of the herniated stomach was slightly adherent to the pericardium and to the edges of the opening in the diaphragm: was freed with blunt and sharp dissection associates and the gap closed with the technic explained in other part of this paper. Recovery uneventful and complete; stomach slightly ptosed; general conditions most satisfactory, the patient having still some slight pain in the chest and slight tachycardia on physical exertions, but feeling otherwise perfectly well and being able to attend to military duties.

COMMENT ON CASES REPORTED

It seems to us that our statements that diaphragmatic hernia is more frequent than it is thought to be, and that its diagnosis is essential for a rational treatment of patients, who might suffer also on account of some other pathological condition, beside the diaphragmatic hernia, are substained by the cases reported which seem to us very instructive. In fact, in none of these cases the diaphragmatic hernia had been diagnosed, in two not even at the operation, and in the third one (Case II) was discovered *only accidentally by the writer,* so that all these three cases would have probably ended in death, that would never have been attributed to the exist-

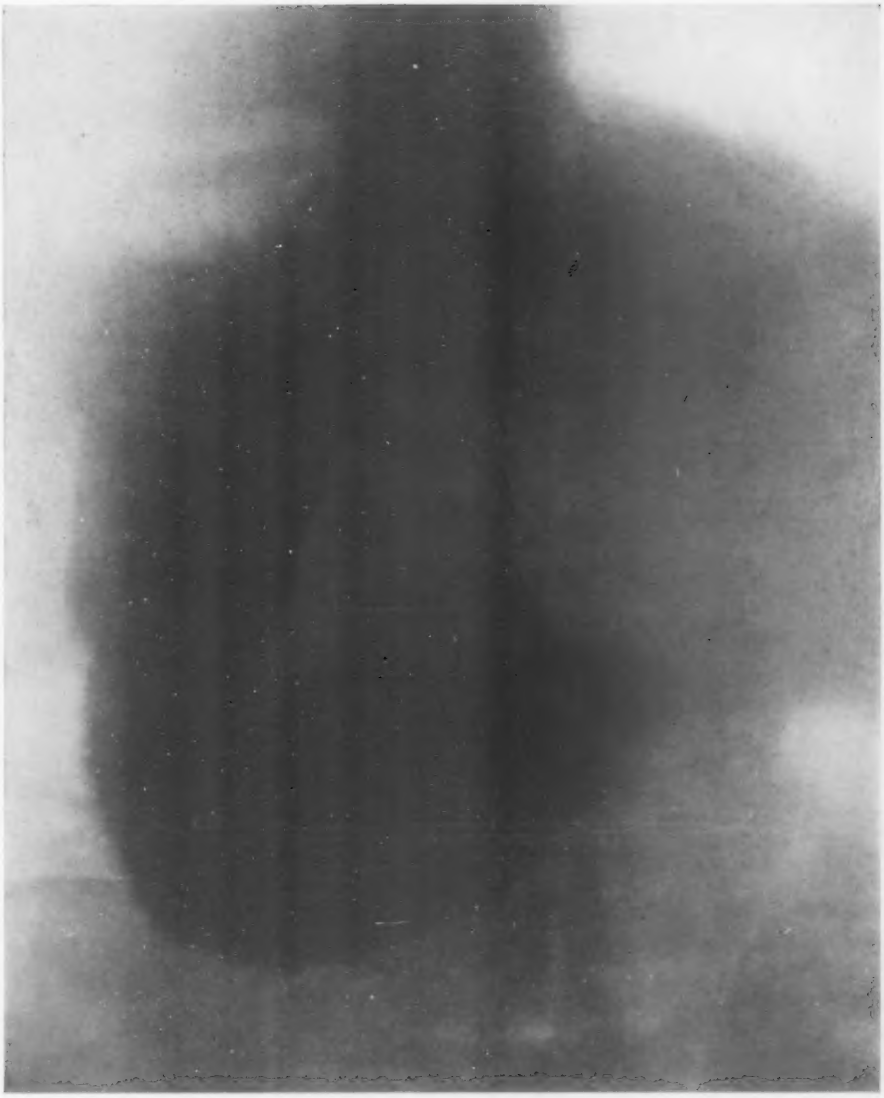

FIG. 1.—X-ray picture of Case I after operation. Only ptosis of the stomach is observed.

FIG. 2.—X-ray picture of Case II. The small diaphragmatic hernia found at the operation does not appear at all, the picture showing only an intimate union between posterior wall of stomach and jejunum.

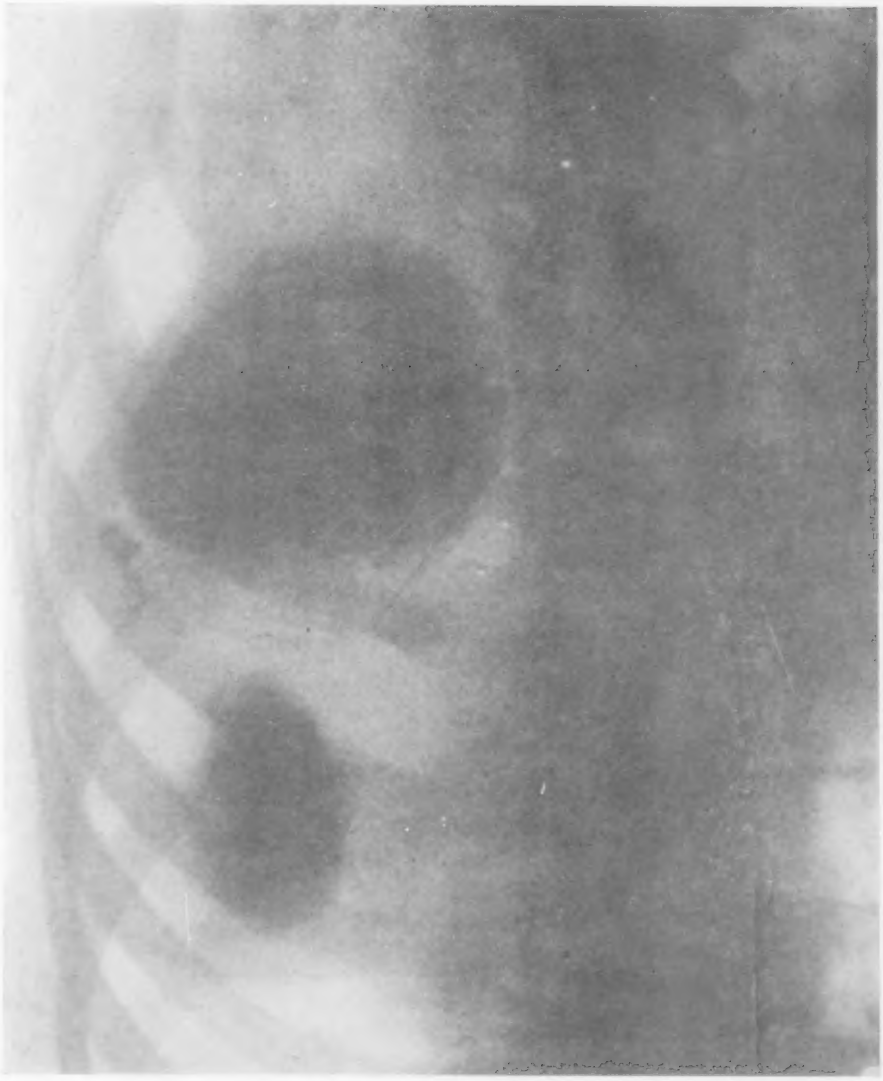

FIG. 3.—In this picture is very evident the portion of the stomach that passed through the diaphragm (Case III).

FIG. 4.—Appearance of hernia of portion of the stomach through an opening in the diaphragm.

FIG. 5.—Same as Fig. 4, with stomach brought back in the abdominal cavity.

ing diaphragmatic hernia. The second statement, that the diagnosis of diaphragmatic hernia is essential in order to cure patients who might suffer also from other pathological conditions associated with the hernia, and that the surgeon should inspect carefully the diaphragm, when he opens the abdomen, we do not think needs any demonstration, after its absolute necessity is plainly demonstrated by the cases reported. In fact, Cases I and III were physical wrecks, and would have died unless reoperated a second time, and the same could be said of Case II, if his hernia had not been accidentally discovered: Cases I and III had been not only operated upon uselessly, but their troubles were thought to be due to nervousness, exaggerated sensitiveness, neurasthenia and what not; which fact calls for sad reflection on the practical medical science. And we believe that the cases reported are also instructive, because they show that if we have to look for lesions of the diaphragm in all cases in whom there has been a wound around the region of the diaphragm, we should also look for congenital lesions of the diaphragm, which would seem to be also more frequent than we have been thinking.

Varieties of Diaphragmatic Hernias.—Diaphragmatic hernias are either congenital or traumatic, or could result from a collection of pus formed on either side of the diaphragm, that would have destroyed or greatly weakened the diaphragm at the point of its formation. The mechanism by which traumatic diaphragmatic hernias are produced, is easily understood, the diaphragm being torn or cut and the gap resulting from the injury remaining open; or healing imperfectly and then breaking again later.

Congenital hernias do not need to be present at birth; hernias should be considered congenital, when they are formed, because there is a weak point in the diaphragm at birth; this weak point is generally situated around the œsophageal opening; not having the possibility of consulting the literature at the present time on account of war conditions, we do not know if there are on record cases of hernias through the opening for the passage of the aorta or of the vena cava. The diaphragm being formed by the union of several muscles, which merge their tendinous portions toward the centre, hernia might result from any of the points where these muscles and their tendons merge one into the other, either because they do not unite, or because their union being weak, cannot stand the hard work to which the diaphragm is subjected. For obvious reasons diaphragmatic hernias are practically all situated on the left side, because on the right the large mass of the liver forms a kind of protecting pad for the diaphragm. Diaphragmatic hernias differ from other hernias because, for obvious reasons, they are deprived of an enveloping sac.

Diagnosis with the Help of the X-rays.—We have already dealt with the diagnosis of diaphragmatic hernias, we shall only add a few words on the help that the X-rays can lend and how to employ them. When the physician thinks of the presence of a diaphragmatic hernia, a careful

study of the X-rays will in many cases make the diagnosis clear; the herniated organs showing themselves above the diaphragm, these will show more clearly in their pathological position, the larger is the hernia and more voluminous the herniated organs. In small, very small hernias, however, the X-rays will not show any change in the position of the abdominal organs in every case, or and often a diverticulum of the œsophagus will be diagnosed, while one has to deal with a diaphragmatic hernia around the œsophageal opening: in these cases it is sufficient that the physician should think of the possibility of having to deal with a small diaphragmatic hernia, and by examining the patient under different angles and in different positions, might be able to detect the real condition.

When there is suspicion of the existence of a small diaphragmatic hernia that is not revealed by the X-rays examination, we advise the following procedure, which enabled us to make a diagnosis in a case that is not reported, because the patient having refused to be operated, we could not confirm the diagnosis made. The patient is given a mucilage of barium sulphate, made up with syrup of gum or better with tragantha, so as to have a good and uniform suspension of the barium. The patient is examined in the standing position looking at the physician while he drinks the barium mucilage, and the abdomen is massaged: if the hernia does not show itself the patient is examined changing his position from one side to the back, to the other side and again facing the physician. If the examination is still negative, the patient is examined laying on the throcoscope, changing the positions, as done when he was in the standing position; if the examination is still negative, the patient is put on a slight Trendelenburg and instructed to breathe deeply, and then relax the abdominal muscles and by stopping the respiration also relax the diaphragm; if the examination is still negative a massage of the abdomen over the stomach and continued examinations might reveal the presence of the hernia, which had not been seen previously. We advise to follow the technic that we have mentioned, because the barium might not go immediately in the portion of the herniated organ or the organ might not go through the gap at certain moments, and the little hernia is then overlooked, with the added danger to the patient coming from having excluded its existence by an incomplete X-rays examination.

Treatment.—It is obvious that the treatment of diaphragmatic hernia must be surgical; the possible existence of a small or large diaphragmatic hernia is of great interest for both the physician and the surgeon, but once the diagnosis is made or suspected the patient belongs to the domain of surgery. The classical manner of dealing with diaphragmatic hernia is to operate from the chest; we do believe that the chest route should be used only in exceptional cases; the safer and more rational route is the abdominal. In fact, most diaphragmatic hernias will be diagnosed only while operating on abdominal organs, and even if the abdomen had not

been opened, the patient being operated upon through the chest route, the abdomen should be explored in all cases of diaphragmatic hernia, for the possible and probable co-existence of other pathological conditions, either secondary to the hernia or independent from it. It would be a useless and dangerous procedure to open the chest, when the hernia can be completely reduced and its reproduction prevented by operating through the abdomen. The chest route should be reserved for those cases in which the herniated organs have contracted strong adhesions on account of which their liberation is not possible through the abdomen. By the expression their liberation is not possible, we mean to refer to the cases in which the herniated organs have contracted such strong adhesions, that they cannot be freed without causing serious damage either to these same organs, or to the organs with which they have contracted the adhesions. So if the surgeon feels that he cannot easily free the herniated organs without tearing them, or tearing the organs with which they have contracted adhesions, he should stop and open the chest. On the basis of experimental work, we believe that the opening in the diaphragm could be widened in all cases in order to avoid the necessity of opening the chest for the freeing of the herniated organs, because with the technic that we shall describe later, the gap in the diaphragm can be sutured in such a strong and safe manner that there is nothing to fear in widening it. If only slight bleeding should result from breaking the adhesions, the surgeon can do the whole reduction of the herniated organs and the closure of the gap through the abdomen and provide for the drainage of the blood which might ooze out of the lacerated surfaces and collect in the chest, with a stab wound made with a scalpel passed through the diaphragmatic opening and stabbing the chest wall between the two ribs located over the posterior cul de sac of the pleura at its lowest point, and introducing a drainage into the stab wound, which would also provide for the exit of any material that could form on account of the trauma and possible infection of the thoracic organs. If the herniated organs cannot be reduced through the abdomen, the chest is best opened by making an incision of the necessary length through the intercostal space, which will be found to be the most convenient, the ribs being held apart by strong retractors; good retraction will in almost every case avoid the necessity of resecting any ribs. The advantages of the chest and abdominal routes respectively are: by the chest route the whole condition of the herniated organs is seen plainly and can be dealt with in the most thorough and perfect manner; there are in the thorax so many important structures with which the herniated organs can contract adhesions and the freeing of which might be extremely difficult and dangerous, that the importance of the chest route, or better the absolute necessity of resorting to it, cannot be over emphasized when the herniated organs cannot be easily reduced. The advantages of the abdominal route are, that it avoids the necessity of resorting to open widely the

thorax, which procedure, if not as dangerous as it was formerly, is always more dangerous than the opening of the abdomen, which, as said above, should also be opened anyhow, in every case of diaphragmatic hernia, in order to examine the conditions of the abdominal organs and repair any pathological condition that might be present in the abdomen.

In difficult cases the chest and abdominal route can be advantageously associated, the freeing and reduction of the herniated organs being done by the harmonious work of the surgeon and his assistant, as is done, for instance, in some cases of combined abdominal and vaginal or abdominal and perineal work.

We shall not dwell on the general technic of dealing with a diaphragmatic hernia, the operation, however, should be reserved to men who are masters of surgical technic and not to beginners or to amateurs, the difficulties that can arise might require the greatest coolness and mastery of every detail of technic. We only shall spend few words on the technic of freeing the herniated organs.

The main dangers in freeing the herniated organs come from possible shock and laceration of important structures. Shock can be reduced to a minimum or prevented almost completely by avoiding any pulling on the organs that are herniated and on the organs to which the herniated organs are adherent, by operating rapidly and with perfect technic, and by avoiding all unnecessary traumata. The organs which might have contracted strong adhesion must be freed by clean and sharp dissection and not by tearing the adhesions with the finger; clean and sharp dissection done with perfect technic will avoid laceration, unnecessary trauma and pulling of such delicate and important structures as the pericardium, pleura, lungs, œsophagus, diaphragm, stomach, blood-vessels, nerves, intestines, etc. The dissection should always be carried on in such a manner that the less important and more easily repaired organs might be injured; that is, for instance, given strong adhesions between the stomach and the pericardium, œsophagus, etc. The dissection is made very close to the stomach, which even if it should be accidentally opened, can safely and rapidly be closed and repaired. To do this work satisfactorily long incisions are indispensable: they give not only more room but allow a better view of the different organs, which must be under the complete control of the operator, if unforseen and perhaps fatal accidents have to be not only prevented, but possibly repaired, if they should occur, notwithstanding all the precautions the surgeon might have taken. Full view of the organs concerned in an operation for diaphragmatic hernia, is best obtained by giving the patient the Trendelenburg position, when the operation is performed through the abdomen, and putting a pillow under the side of the chest that is not operated upon, in order to widen the intercostal space as much as possible, when the operation is performed by the chest route. The best manner of illuminating the operative field is the use of a frontal lamp, with which the surgeon can really

throw the light where it is needed and avoids the encumbrance caused by lamp post or by the person holding the lamp; we believe the front lamp to be almost indispensable in order to operate in the very best manner on the diaphragm.

Closure of the Opening in the Diaphragm.—The safe and perfect closure of the opening in the diaphragm is obviously of the utmost importance: the suture that is used in approximating the two edges of the opening has to fulfil the following indications: it has to approximate very closely, without tearing them, the edges of the opening; the suture should prevent tearing of the diaphragm later; the suture has to close in the most perfect manner the opening of the diaphragm, especially around the organs that pass through it, œsophagus, cava, aorta, nerves, when the opening is found around them, but without compressing the important organs just mentioned; the suture should not cause the perforation or inclusion in the suture itself of any thoracic organs; the suture should strengthen, if possible, the sutured portion of the diaphragm.

The importance of these points cannot be over emphasized: the diaphragm is a compound of several muscle bundles which unite forming a broad, central, strong tendon; the diaphragm on account of its important function cannot stop its work, when the opening that resulted in the formation of the diaphragmatic hernia is sutured, *the edges have to adhere and form strong and permanent adhesions, not while the diaphragm is at rest, as it could and does happen in other parts of the body which can be put at rest, but while the diaphragm is working.* To emphasize the importance of this point, we can compare the healing of the sutured parts making up, for instance, an epigastric or an inguinal hernia or still better a hernia in the abdominal walls secondary to a laparotomy: the ordinary suture would hold very seldom if the patient immediately after the operation, was not put in a position of complete rest and kept there for several days, but was compelled to strain the sutured sturctures without a moment rest. And the importance of a complete healing and formation of strong union between the edges of the opening in the diaphragm is also made evident by the fact, that if strong union does not take place, a second operation will be necessary; operation to which the patient might object, thinking that the surgeon who has not cured him at the first operation, did not know what his ailment was, or was a poor surgeon, or distrusting all together the ability of surgical science to effect a cure. This last point is very important, because, as we have said before, the diagnosis of diaphragmatic hernia is only seldom made, especially when the hernia is very small and so the patients suffering from it are not properly treated and go from one doctor to another and when finally they are operated upon, if they are not cured, they will loose all confidence in medical and surgical science, and be physical wrecks for life.

The ordinary suture does not close completely the opening in the diaphragm without leaving any gap between the stitches and through

these small gaps the abdominal organs could pass again in the thorax; this is especially true of the gap that is left around the œsophageal foramen, through which the stomach can easily find a way into the thorax again, if it is not most completely and securely occluded. The importance of occluding even the smallest gap, so that the diaphragm has to appear and be a strong uninterrupted structure, is understood, when we consider what we said previously of the continuous uninterrupted working of the diaphragm, which might, and in all probability will, cause any small opening to widen, but certainly not to get narrower and finally become occluded. The importance of not compressing any structure, that is included in the closing of the gap formed in the diaphragm, has only to be mentioned to be appreciated, and the same thing can be said about injury of any thoracic organ. The ordinary suture does not strengthen the diaphragm along the suture line; on the contrary, it weakens it, and the importance of strengthening the suture line is plain, when we think that diaphragmatic hernias either congenital or acquired result always from the fact that the diaphragm became weak or its continuity was interrupted at the point where the hernia has formed, so that this point must be made as strong as it is possible to make it. We hope that the suture we have devised, and that we use also in epigastric hernias, and in hernias of the abdominal wall, will be found useful in the diaphragmatic hernias by other surgeons, as it was found useful and serviceable by us.

Suturing of the Diaphragm.—The suture we recommend because we have found it to be most satisfactory both in clinical and experimental work aims to approximate the edges very closely, in fact, it overlaps them, and to keep them closely approximated. The stitches are put in such a manner, that they cannot tear the tissues, but can stand any amount of strain from the very moment they are put in. In this manner the continuous hard work made by the diaphragm, can be done without fearing that the suture might cut the structures which it has united. Our suture closes up the corners of the gap securely and completely; in fact, we think that it fulfils all the conditions we believe to be essential for a good suture of the diaphragm. The illustrations show plainly how the suture is applied; silk, preferably black, is threaded on a curved needle, the index finger is passed under the edge (Fig. 6) and the needle takes a bite parallel with the edge of about three or four millimetres, the two ends of the thread are caught with an artery forceps. Another stitch is taken along side of the first one and so on until sufficient stitches have been put on both edges (Fig. 7). The corners are dealt with in the following manner: The needle enters the edge under its middle and makes a kind of purse-string suture around the edge, coming out close to the last stitch (Figs. 7, 10 and 11); the same thing is done with another needle in the opposite direction. When all these stitches have been placed (Fig. 7) we have before us a series of stitches parallel to the cut edges: the next

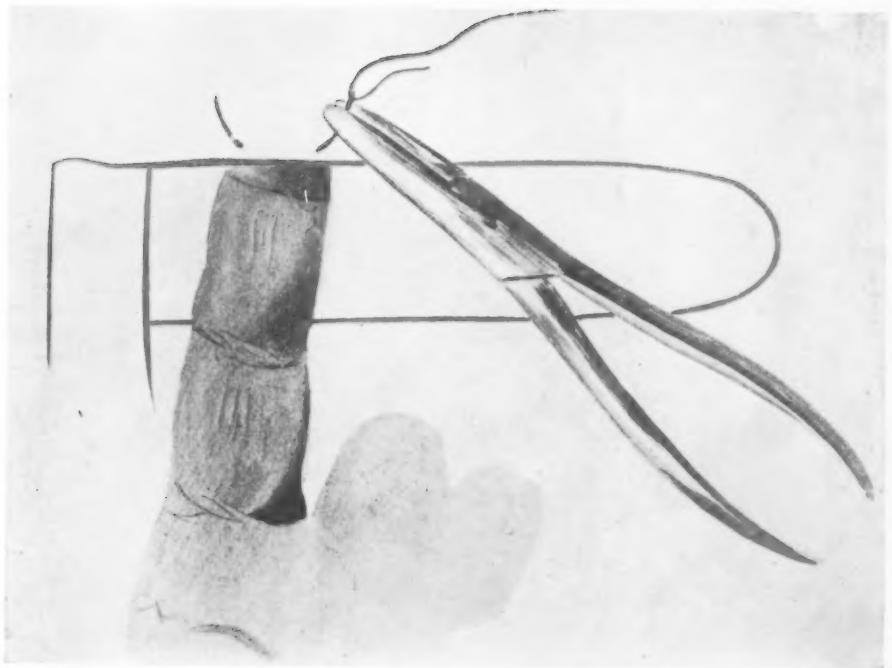

FIG. 6.—Manner of putting sutures that will close the gap in the diaphragm: the index finger preventing any organ to be included in the suture.

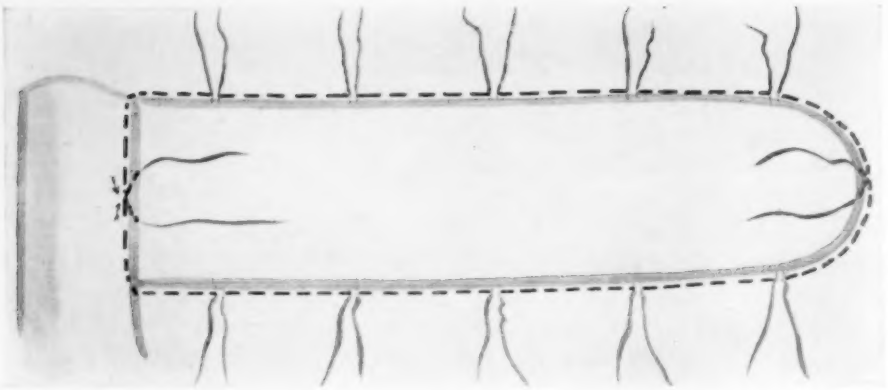

FIG. 7.—Stitches placed all around opening in the diaphragm.

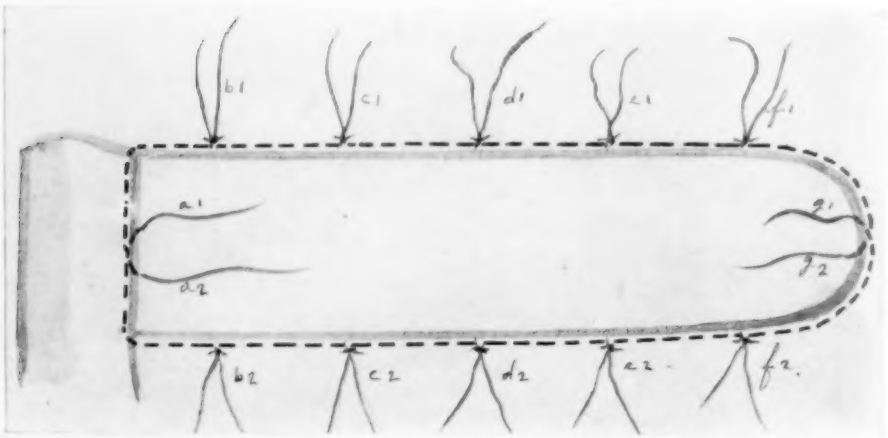

FIG. 8.—Stitches being tied to each other, each thread tied with its neighbor.

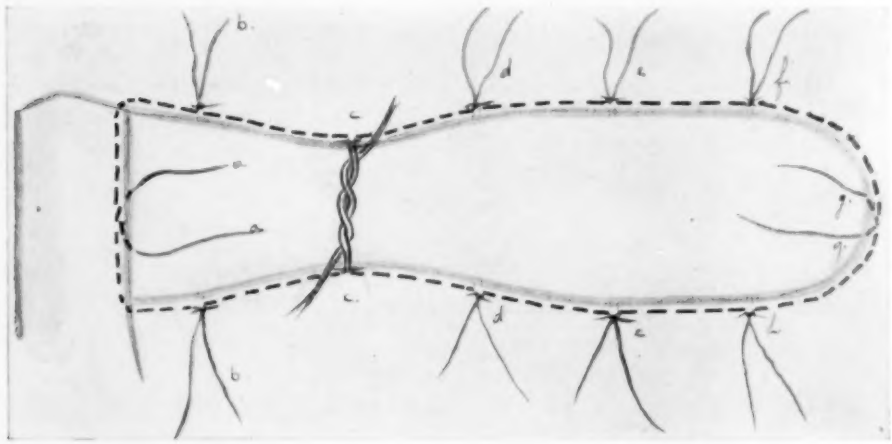

FIG. 9.—Closing gap in the diaphragm by tying together stitches opposite to each other, *a* with *a*, *b* with *b*, *c* with *c*, etc.

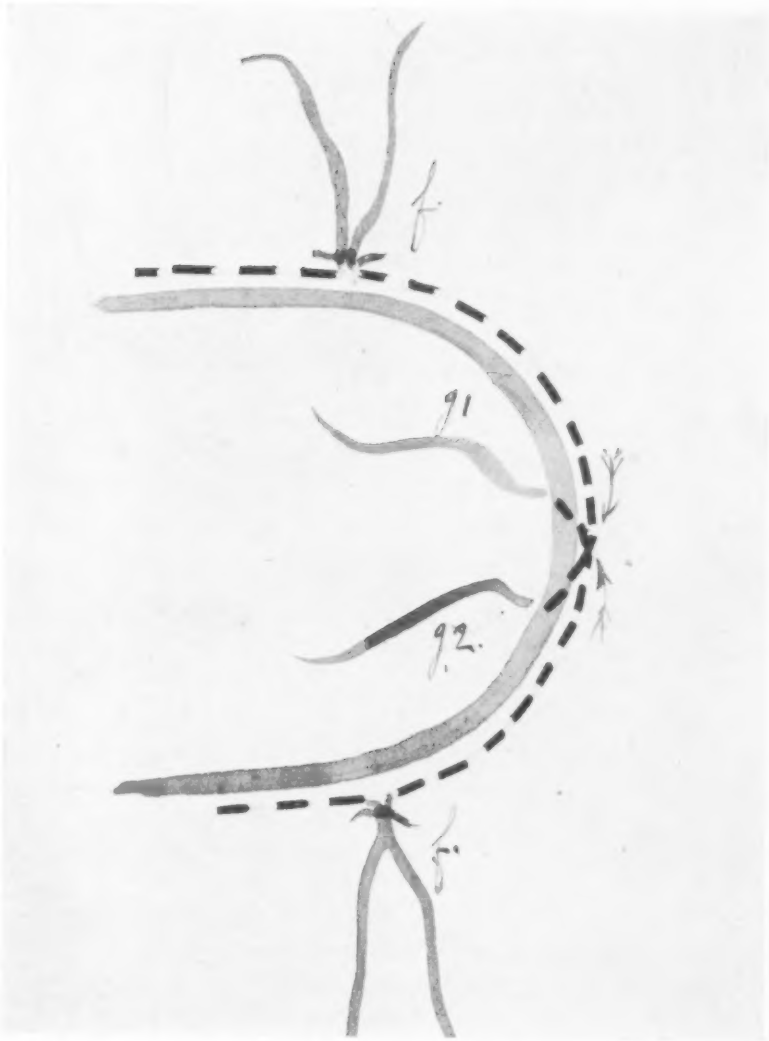

FIG. 10.—Details of how to close corners—note how threads *g1* and *g2* overlap each other, so that when they are tied they approximate securely the parts that have been sutured.

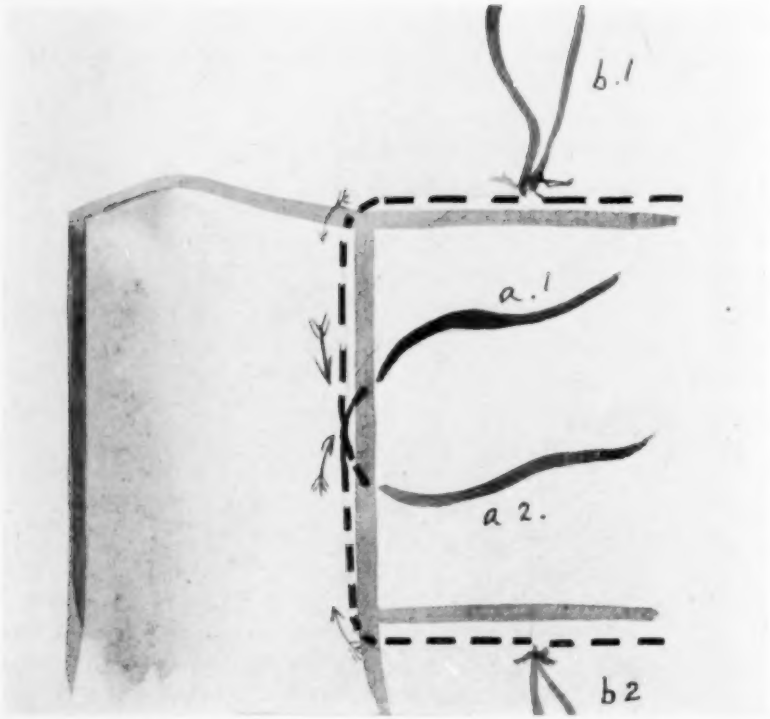

FIG. 11.—Details of how to close diaphragm around œsophagus, threads *a1* and *a2* enter the superficial layers of the œsophagus and are pulled and tied together after stitches b1 and b2 have been tied, so as to occlude completely the gap around the œsophagus; for clearness illustration shows threads entering the lumen, in actual operation this will not happen, if only superficial layers are interested with the suture.

step is the tying of the ends of the stitches which emerge near each other on either side of the gap (Fig. 8). When all the ends of the threads have been tied, all the stitches form a kind of continuous line on each side of the gap, which is then closed in the following easy manner. The ends of the stitches that have been tied together, are tied again with the ends of the stitches of the opposite side (Fig. 9) and the two corners are also securely closed by tying the ends of the stitches that were put around them (Fig. 10).

If the œsophagus or the cava or the aorta are found in the gap of the diaphragm the stitch is somewhat modified, the needle goes through the most superficial layer of the organ that is included in the gap, as shown in the illustration (Fig. 11). Naturally the surgeon must be exceedingly careful in not entering the lumen of the organ, it is sufficient to take in only the very most superficial layer of the organ in order to obtain a perfect closure of the diaphragm around it; in our clinical work we had only the occasion to suture the diaphragm around the œsophagus, but we tried to suture it around the aorta in some experimental work and the results were absolutely perfect. Anyhow, around the organs included in the area, where the hernia is formed, there is always some amount of scar tissue through which the needle can be passed with perfect safety, without any fear of entering the lumen.

It is seen that with the suture we have devised, the gap in the diaphragm is securely closed and no strain is put on any single stitch, the suture being made by single threads which form a continuous line on each side of the gap and pull together without the possibility of cutting the parts that have been sutured, the tension being not on any single stitch, but on the whole line. We recommend the use of black silk, because it is more easy to place properly the stitches, if the silk is black and therefore easily distinguished from the surrounding tissues, than if material of neutral color, such as plain silk, was used; we prefer silk to catgut, because silk will not be absorbed, is incisted in the scar tissue and therefore renders the scar stronger.

After-treatment.—Although the suture we have recommended is strong enough to stand any strain, it will be preferable to instruct the patient to breathe with his chest, so as to strain as little as possible the diaphragm. The patient can be fed as soon as he feels like taking food, but it is advisable not to give any drink or any food until the surgeon is sure that the patient shall not vomit, because naturally vomiting will put a great strain on the diaphragm, strain that can be avoided by witholding drinks and food until the patient shall not vomit. This point is more important in cases of congenital hernias due to weakness in the structure of the diaphragm, because the suture cannot make the tissues stronger than they are naturally, and if the suture is made on tissues with little resistance, it is obvious that the suture might hold, but that the tissues might tear, if too much strain is put on them, and therefore it is advisable to

avoid all unnecessary strain. The patient should be kept in the position that he finds to be the most comfortable, so as to allow the greatest ease in breathing and should get up when he feels that he can breathe without any discomfort.

We may be allowed to suggest a very comfortable dressing that we use in all our laparotomy cases, and which was found especially useful and comfortable in our cases of diaphragmatic hernias. Before the operation we have the patient wear for a few days, when this is possible, a well-fitting, elastic abdominal belt; when the operation is completed we dress the wound in the following manner: we put several layers of gauze over the sutured wound and apply on the abdomen the elastic belt. We do not believe that there is a more rational and comfortable dressing, especially if the patient has been accustomed to wear his belt for a few days previous to the operation. Patients who had been operated twice on the abdomen declared that the comfort they experienced with the simple dressing made with the belt was really wonderful, and comparing the feelings of uneasiness and in some cases of real suffering caused by the other dressings now in use, they all declared that the elastic belt had robbed the operation of some of its most unpleasant features. We advise the patient to wear the abdominal belt for some time at least, because it seems that the stomach has a tendency to fall down in the abdominal cavity, as we have clearly seen in our cases. After a certain time, abdominal massage and deep breathing exercises will be found very useful.

In conclusion we shall recommend again to look for the small diaphragmatic hernias, to persist with the X-ray examinations, when there is some doubt about the probable existence of the hernia, and to inspect carefully the diaphragm in all cases in which a laparotomy is performed in order not to overlook existing diaphragmatic hernias, remembering, that the smaller they are, the more easily they can be overlooked and will give rise to obscure symptoms, which might render quite uncomfortable the patient's life, unless the hernia is properly operated upon.

We believe that the diagnosis is made more easy and the operation best performed if the indications given above are followed.

GAS AND THE MOTILITY OF THE SURGICAL STOMACH *

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A certain amount of gas undoubtedly always exists in the normal stomach although there may be no consciousness of its being there and there is obviously a purposeful relationship between this intragastric gas and the stomach's motility. Throughout the stomach and intestinal tract this contained gas apparently becomes an almost indispensable medium for the origination and perpetuation of the peristaltic contractions and for the coördination of the colonic, enteric and gastric waves with one another. Whenever an irritable focus arises at any site along this visceral tract or in any coördinated system of intra-abdominal organs the whole functional picture changes, and particularly the expression of the stomach's activity. Under these conditions, intragastric gas, although it may not have increased in quantity, becomes superfluous and often burdensome and, by the patient, is blamed as the immediate cause of his illness.

The question of vagotonia and sympathicotonia is again brought up in the discussion of the surgical stomach. The objections to this nomenclature are: (1) The innervations by the autonomous and sympathetic fibres are not understood, much less generally agreed upon; and (2) it needlessly revives the fundamental consideration of the origins of disease: whether disease is purely functional and then morphological or whether morphological and then functional. The solution of the etiology of disease is a philosophical one and peculiar to each individual. Surgery is concerned with the elimination of the functional disorders and applies itself to the material causes of disease. The stomachs described in this paper can only act in their own terms if they act at all. Certain stimuli are set in motion by producing diseased conditions of the appendix, gall-bladder, duodenum, or stomach, and the stomach responds with changes in motility. It is not improbable that purely chemical causes may bring about diseased conditions in these organs, that the physiology of the organs of internal secretion may have allowed these chemical causes to work harm to the individual, and, even more remotely, that inheritance may have been responsible for the insufficiencies of certain ductless

* This paper was undertaken to answer questions that have come up in the course of surgical teaching; such as, "Why hypermotility in some instances and pylorospasm in others of chronic appendicitis?" "Why epigastric cramp in gall-bladder disease?" "What gives rise to the incisura in the normal stomach?" "The significance of gas in stomach contraction?" etc.

glands, but, in the rational treatment of morbid processes, one has to start somewhere and surgery elects to attack the material causes.

However responsive the stomach's behavior may be to disturbances elsewhere within the abdominal cavity it does not appear that relaxation and dilation will progress to dangerous limits. The few and isolated cases reported seem to be instances in which the structure of the stomach has been impaired. Gill's [1] case apparently comes the nearest being a real spontaneous rupture of a normal stomach, but even here, during the forty-eight hours of gastric dilation, two doses of atropin had been administered. The responsive nausea, the possibilities of personal idiosyncrasy and of selective drug action are so great that a negligible depressive action of the drug can scarcely be excluded. Batelli,[2] in 1896, showed that atropin may be followed by a loss in gastric tonus and contractions, in vagus excitability, and in splanchnic action. A normal stomach is protected against dangerous distention by eructation and vomiting.

The origin of the stomach gas is in doubt. The possibilities are obviously air that has been swallowed, duodenal gas that has been eructated through the pylorus, as bile and duodenal secretions are eructated, or, finally, an end-product of stomach chemistry or of gastric metabolism. The analyses of stomach gas correspond with those of expired air and this similarity suggests atmospheric air as its basis.

The functional significance of this gastric gas has been studied clinically as well as experimentally. From recent surgical writings, it is apparent that observations are being made during clinical operations upon the motility of the stomach, intestine and ureter. The common bile-duct belongs in the same category of hollow viscera but its peristalsis is probably still of physiological interest only. Ureteral peristalsis has been called attention to as a convenient means of differentiating the ureter from a blood-vessel. Gastrospasm and enterospasm are frequently seen after handling these organs in the human subject, and gastric peristalsis has often been displayed and its relationship to peritoneal traumata brought out in clinical teaching. The pyloric and ileocolic sphincters, under the same nervous control as the rest of the hollow viscera, are frequently investigated in respect to size and tone. It is probable that these findings very well correspond with the fluoroscopic and X-ray studies as well as with the observations upon experimental animals. This is very important because it makes possible more prolonged and better controlled studies of human surgical problems upon brute animals.

In order to bring out the relationship of stomach gas pressure to stomach contractions, four experiments were performed upon the canine stomach during the digestive period and under morphine-ether narcosis. The intragastric tension was measured in millimetres of water on a manometer connected up with the anterior wall of the stomach. The traumatization of introducing the canula tip increased the force and, pos-

sibly, the rate of the peristaltic contractions for the first few seconds but the waves continued on by the canula to the pylorus. Air, forced into the stomach, raised the pressure of the contained air and registered on the manometer.

Experiment 207.—A normal two-cycle stomach with peristaltic contractions recurring every twenty seconds and with an intragastric pressure of 30 mm. Each respiration raised the pressure 10–20 mm. and each prostaltic wave 5–15 mm. The greatest rise occurred at the time the proximal wave was at the pylorofundic junction and the distal one was at the pyloric sphincter.

The pressure was raised from 30 to 90 and the variations ranged between 85 and 100; these variations were respiratory only for the peristalsis had disappeared.

The pressure was lowered to 70, to 60, to 50 and to 40, successively, before peristalsis was observed again in the stomach. When reduced to the normal 30 the waves appeared as above with the same periodicity but with slightly reduced force.

There was heard at this time and through the remainder of the experiment a distinct pyloric rumbling, fairly low-pitched, synchronous with the appearance of the through-prostaltic wave at the pylorus.

The stomach was emptied of its gas, and, while the contractions continued every 20 sec., they were weak, and the gurgling disappeared.

At 15 and 25, the soufflé reappeared. At 50, the motility was pyloric, with an occasional through-wave and gurgling. At 70, 80 and 130, "through" waves persisted, but with irregularity in rhythm and force, and the intrinsic pyloric motility had disappeared. Respirations continued to exert their influence, very strong inspiratory efforts forcing the water out of the manometer.

Conclusion.—Waves of gastric contractions persist during a given activity period whether the intragastric air pressure is normal: 30, hyponormal: 15, zero, or greatly increased: 70, 80, 130. In a normal animal the strongest contractions appear to coincide with the normal intragastric gas pressure, 30.

These findings agree with those of Cannon [3] on the cat, the conclusions of which, he summarizes as follows: "Gastric peristalsis results from tension produced by internal pressure acting on the tonically shortened gastric musculature, for (1) distention of the inactive stomach causes peristalsis when the musculature is tonically shortened but not when it is relaxed; (2) considerable intragastric pressure (sustained tension) prevails in the stomach manifesting peristalsis; (3) within limits peristalsis is augmented or weakened as intragastric pressure is experimentally increased or decreased."

Surgery recognizes two points in intragastric pressure: that which exceeds the physiological limit and that which falls below that limit. The former is known as dilation of the stomach and the latter is a partially collapsed stomach occurring in perforating ulcer and traumatic rupture. From the above observations, it appears that the motility is diminished whether the pressure is abnormally high or low. In acute dilation and in perforating ulcer the immediate treatment outweighs all other considerations, but in the chronic stomachs with abnormal pressures and abnormal motility, the treatment of the causes of these distentions or motor changes is desirable.

The etiological treatment of dilation, whether prolonged as in mechanical closure of the pylorus or spasmodic as in the so-called "stomach-reflex" conditions, involves the study of a great number of possible causal factors. Whatever the origin of the gastric spasms, whether they be "reflex" or due to changes in intravisceral pressure (Cannon), or due to changes in the gradient of contractility (Alvarez [4]), or whether the spasms depend upon one or more of these conditions as associated factors, symptoms of distention are complained of by the patient and abnormal motility is observed by the examiner. The motility may be increased, decreased, reversed, or spasmodic.

The significance of pylorospasm differs with the conception of "pylorus." If by "pylorus" is meant the projecting edge of the pyloric end of the stomach into the duodenum, then pylorospasm is limited to an arbitrarily small segment of the stomach. If by "pylorus" is meant the pyloric end of the stomach or the "surgical pylorus," then pylorospasm becomes a diffuse spastic contraction and is qualitatively identical with hypermotility. The former is of myogenic origin [5] and of the nature of gastrospasm and the latter rises from irritation from within and from without the stomach as well.

Of the three physiologic portions of the stomach: the canalis gastricus, the saccular fundus, and the active pylorus, the pylorus, comprising the greater part of the organ that appears horizontally at laparotomy, is principally concerned in hypermotility. Fright stirs up very active peristalsis; so do appendicitis, duodenal ulcer, gall-bladder disease and lesions of the stomach itself: ulcer and cancer. Graham [6] writes that "bloating and pressure are more common in gastric than in duodenal ulcer," while in gall-stones "the gas present intensifies the distress and belching gives short relief." In these conditions, the irritation may be so intense as to convert hyperperistalsis into gastrospasm with retention instead of early emptying as the clinical manifestation. These phenomena account for the pain which Carlson [7] has associated with the gastric contractions and also for the abdominal distention.

Experiment II.—Fasting stomach corresponding to stomach of patient "prepared" for operation. Stomach powerfully contractile, with loud pyloric soufflé and of three cycle type.

(1) Index finger extended beneath lower angle of wound over parietal peritoneum as though about to raise the angle of wound for inspection. Result: Dilation of stomach, with absence of contractions for a few seconds, normal prostalsis and pylorospasm.

(2) Cæcum (appendix) clamped and released. Result: Dilation of stomach, with absence of contractions for three min., normal prostalsis and pylorospasm, slight irregularity in time and force.

(3) Gall-bladder clamped and released. Result: Dilation of stomach, with absence of peristalsis for three min., prostalsis and pylorospasm, increased irregularity in rate and increased force.

(4) Stomach at lesser curvature of pyloric region clamped and released. Result: Dilation and no contraction for a few seconds; strong retrostalsis beginning at pylorus

and progressing orderly to pylorofundic junction where the contractions disappear. (In the voluntary animal this would probably be accompanied by vomiting. This reversed peristalsis is therefore to be regarded as purposeful: as an effort to remove the irritation through the mouth.)

Conclusion.—Appendix and gall-bladder diseases are associated with hypermotility, including pylorospasm. Pyloric disease gives rise to reversed peristalsis.

From the above experiment it appears that relaxation and contraction of involuntary muscle are balanced against each other very much as they are in voluntary muscle. Peritoneal traumata appear to cause cessation of the stomach's contractions and stimuli from the intestinal tract seem to start the contractions up again. There are doubtless innumerable extraneous causes of gastric hypermotility, and these experiments are significant in that they depict as possibilities certain common surgical findings in the human abdomen.

Similarly in three out of five animals trauma to the gall-bladder was followed by retrostalsis in the stomach and in the remaining two by forcible prostalsis or hyperperistalsis. These findings again correspond with the vomiting and epigastric cramp of gall-bladder disease. Clamping of the ureter is more difficult and necessitates a greater amount of peritoneal trauma which, in turn, is followed by a longer atonic gastric phase and the stomach contractions, when they do appear, are diminished normal (two experiments). Clamping of the pancreatic duct has been followed in one case by intense stomach cramp. Disturbances in the stomach and duodenum, due to diseased foci in other organs, differ from disturbances following localized lesions in the stomach and duodenum in this respect: that in the former instance there is general hypermotility, pylorospasm, or duodenospasm and in the latter there may be hypermotility but there is more likely to be localized gastrospasm or duodenospasm. In both types of stomachs and duodeni, there may be hypertonicity and hyperperistalsis, although in a few instances there are hypotonicity and diminished or absent peristalsis, but segmental spasm or the incisura is particularly characteristic of the localized lesion.

In subacute and chronic conditions the duration of the exciting cause: appendix, gall-bladder, or duodenal ulcer, implies that so long as the stomach remains anatomically normal it must repeatedly manifest hypermotility and pylorospasm. Röntgenographic evidences of hyperperistaltic stomachs in these cases as well as occasional accidental inspections of hypermotile stomachs in the operative room support this view. Indeed, it is quite generally agreed that the rule in individuals with chronic appendicitis is not only a hypermotile but a hyperfunctionating stomach inasmuch as hyperacidity is often associated with hypermotility.

Gastrospasm includes spasms of any part or of the whole of the organ. There may be spasmodic contractions of the cardiac or pyloric sphincters, segmental contractions appearing as incisuras, diffuse contractions of the pyloric ends, or total gastrospasm. Tetanic contractions of the

sphincters and the "incisuras" are, in surgical cases at least, often indications of local lesions, while diffuse and total spasms are probably qualitatively the same as hypermotility in most cases.

Cardiospasm is probably protective and occurs when the stomach's condition is unfit to receive food. This would correspond with Cannon's findings for the small gut in the presence of caudal obstruction. It follows that local irritation plays an etiological part in the surgical spasm of the cardia. This relationship was illustrated in a personal experience with cardiospasm which was associated with a pin imbedded in the parietal peritoneum and upper left abdominal rectus muscle sheath and which was relieved by the removal of that pin, and also in the suggestive case of Carman [8] and Miller in which duodenal ulcer was found two years after securing partial relief of the spasm by forcible dilation. It is possible that irritation from other parts of the abdomen may give rise to cardiospasm. This is supported by the anatomical researches of Keith [9] on the nodal significance of the cardia, by the heightened irritability described for the cardia by Alvarez,[10] and by the frequency of cardiospasm in high-strung nervous individuals.

Many writers contend the absence of peristalsis follows pathologic conditions of the ileocolic region in support of the so-called ileopyloric reflex. White [11] found that the motor effects of the stomach vary with the degrees of cæcal irritation, that these effects may be reversed peristalsis, pylorospasm, and hypermotility to no effects at all. This agrees with personal studies on the two ends of the small gut in which it appeared that the contractility of the duodenum varies with the end-resistance or obstructive irritation of the ileum.[12] The most frequent failure in motility, clinically met with, is that associated with the fatigue or atrophy of gastroptosis or, in other words, in those individuals of lowered general resistance who often have diminished gastric tone. Dilation follows prolonged pyloric stenosis. Personal experiments herein reported and to be published in a subsequent paper have not found splanchnic inhibition to be vitally concerned in gastric dilation, but they have shown a fairly constant cessation of the gastric contractile waves and gastric relaxation after rubbing of the parietal peritoneum or handling of the viscera which does suggest some form of nervous arc over which inhibiting impulses may travel. Furthermore, it appears that there is a fair constancy in the promptness of dilation succeeding traumata, in the duration of the dilation, and in the tendency of the stomach to remain dilated as the traumata are repeated or prolonged. It is extremely probable that the post-operative dilation of the stomach and that ileus are of this nature.

The phenomenon of reversed peristalsis is a part of normal physiology and when carried to excess is observed pathologically in thin-walled abdomens with pyloric stenosis and dilated stomachs. It may be confined to the pyloric end of the stomach and may continue while regu-

lar prostaltic waves are seen coming from the cardia; or retrostaltic waves from pylorus to cardia may occur alone. The protective function of anastalsis is manifested in the vomiting of acute toxæmias and obstructions.

Summary.—Atmospheric air serves as a basis for stomach gas. Gastric air tends to preserve normal intragastric tension at which the stomach contracts most effectually but above and below which the contractions fall off. Spontaneous rupture of the normal stomach is probably unknown. In dilated stomach the gas accumulates in abnormal amounts and correspondingly influences gastric peristalsis. The cause of chronically disturbed stomachs may lie in diseased appendices, gall-bladders, duodeni, or in other organs. Diseases of the stomach, appendix, gall-bladder, and duodenum may be associated with gastric hypermotility and pylorospasm. Contractions of the stomach and of the intestine occur, under certain conditions, in the open surgical abdomen and appear to be influenced by parietal and visceral traumata. Irritation of the parietal peritoneum appears to inhibit the stomach's motility; irritation of the abdominal organs by handling or instrumentation may stimulate or depress the motor functions of the stomach according to the degree of irritation.

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FATTY HERNIAS

WITH A REPORT OF A CASE OF STRANGULATED FATTY HERNIA ENVELOPING AN EMPTY FEMORAL SAC

By Kelley Hale, M.D.

of Wilmington, Ohio

Before describing this case, I wish to take up the subject in a general way in order to draw the attention of surgeons to this rare or rather, perhaps, neglected field.

After reviewing the literature of the subject which contain only a few, but fortunately most excellent papers; I am inclined to think that the condition is not so rare as would seem.

With the exception of Dr. Joseph Ransohoff's paper (1913) all of the work has been done previous to 1870–1877 and each author has been able to report one or more personal cases. One would naturally conclude, if the subject of fatty hernias had been so thoroughly worked out during a period when, compared with the present, there was very little surgery done, that certainly the modern surgeons have overlooked the subject as evidenced by the paucity of the literature since 1877. It seems rather strange that the attention of the various authors has been drawn to the subject by either encountering a case or being directed to it by a friend.

The author of this paper, after having operated one of these cases, was personally referred by Dr. Joseph Ransohoff, in the Cincinnati Hospital Library, to his excellent paper on fatty hernias; otherwise I may have never known that there was such a subject.

That wonderful surgeon, Ambroise Paré, who has done so much for surgery, was perhaps the first to describe a case of fatty hernia, and in the report we gain an insight into the cause of his greatness, because it shows his unquenchable thirst for knowledge and his ability to make others profit by his labor.

Every abdominal surgeon is well acquainted with the subperitoneal fatty layer. In some patients it is quite thick while in others it is absent in certain areas. A study of cross sections of the above region will give one a better idea of the subperitoneal fatty layer than pages describing it.

If from violence or some other cause the fibres of the fascia composing the linea alba become separated, the intra-abdominal pressure will force first, the underlying fatty layer through the defect and eventually perhaps a peritoneal sac may be drawn through with the fat. The fat may increase into a well defined tumor, which usually has an artery passing into it. Because of the artery it is thought that the rent in the fascia occurs at a point where the former passes through the fascial layer. However, the majority of these fatty hernias occur at the location of and usually, but not necessarily, with inguinal or femoral hernias.

So few cases have been reported, that a classical text book description of the symptoms is out of the question. Therefore, I will make a brief extract of some of the cases that I have been able to find.

CASE I (AMBROSE PARÉ).—"It is a priest of St. Andrew, named Jean Moret, who on Sundays sang to the epistles in the church. He had a large complete intestinal hernia, which he showed me, demanding relief, because he felt severe pain in it, particularly while singing. Seeing his suffering I told him that truly he should put someone in his place. This he did, praying the curate to substitute someone else and bewailing his own weakness. When this was accorded him, he placed himself in my hands and I prescribed several remedies suitable to his sickness, also making him a bandage which he wore during the period of five or six years. One day, asking him how his trouble was, he replied that he did not know that he had any and that he was cured. That, I would not have believed had I not seen it. Therefore, took him to my lodging and saw his genital parts without any trace of a hernia, and I was greatly astounded how he could have been cured in view of his age. About six months after I thus saw him, he died of pleurisy, and being advised of his death, I went to the house of the curate where the said Moret had lived, and prayed that I be permitted to open the dead body, to the end that I might learn what buttress nature had placed in the canal through which the intestines had descended. I protest before God that I found all around the groove of the peritoneum a fatty substance of the size of a small egg and attached so firmly to its surroundings that I had great difficulty in detaching it without breaking or tearing the adjacent parts, and this was the way in which a cure had followed."

CASE II (Reported by THOMAS ANNANDALE. Read before the Medico-Chirurgical Society of Edinburgh, January 5, 1870).—Dr. Annandale's attention was first directed to the subject by Professor Turner, 1860, in the dissecting room. He had made careful notes and drawings of the dissection and loaned them to Annandale. I think it is advisable to give Annandale's full report of the first case because it gives practically all of the anatomical features of a typical femoral fatty hernia.

"Subject, female, eighty-six years old. A large fatty mass was found projecting through the left saphenous opening. It was one and three-fourths inches long and one inch broad at its widest part. It was situated on the pubic portion of the fascia lata, somewhat constricted at the spot where it projected through the saphenous opening, being closely embraced on its outer surface by the superior cornu of that aperture. When the fascia lata was removed and the crural sheath exposed, and the different compartments cut into, the internal or crural canal was found to contain a considerable quantity of fat, which was continuous with the fatty mass projecting through the saphenous opening. In its descent, the mass had projected before it that part of the femoral sheath which forms the wall of the canal. *This investment had a thin transparent shining appearance which might at first sight be mistaken for the sac of the hernia.* When this investing structure was cut through, the fatty contents were found to be distinctly lobular and vascular; the *vessels being continuous with the vessels of the abdominal wall.* A funnel-shaped peritoneal sac was situated in the middle of the fatty mass extending for about half an inch downward. The fat was evidently nothing more than a hypertrophy of the subperitoneal fat of the wall of the abdomen with which it was continuous, superiorly through the crural canal. The peritoneal sac was smooth and transparent. The sac was empty, and its upper narrow end communicated with the general cavity of the peritoneum. The fatty mass was slightly adherent to the exterior of the sac." He describes another fatty tumor size of an almond in same subject which consisted of subperitoneal fat. It had passed through the

split fibre of the conjoined tendon and had as coverings the transversalis fascia and spermatic fascia. It emerged from the external abdominal ring but contained no sac.

Case III (Annandale).—Female subject, dissected 1860, had projecting through the left saphenous opening a mass of fat the size of a small orange and was covered by the femoral sheath. Within the mass was a femoral sac containing adherent omentum. On right side was a fatty mass the size of an almond, within which was a small empty peritoneal sac. It had the same anatomical relations.

Case IV (Annandale).—"Female subject dissected July, 1860. A lump of fat the size of an olive was found in the left crural canal and continuous with subperitoneal fat and crural ring. Within the mass was found an empty cul-de-sac of thickened peritoneum which was closed at the femoral ring by a distinct cicatrix."

Case V (Annandale).—Female subject dissected July, 1861. A mass of fat one inch long protruded through the left saphenous opening and was derived from the subperitoneal fat, it contained an empty peritoneal sac.

Case VI (Annandale).—Dr. Annandale dissected a middle-aged male subject in March, 1864. On the right side, a fatty mass, the size of a pigeon's egg, and on the left a mass a little smaller were discovered; each had pierced the fibre of the conjoined tendon and had carried down a peritoneal sac that communicated with the general peritoneal cavity.

Case VII (Annandale).—A male subject dissected December, 1869, was shown to Dr. Annandale by Dr. Chiene. On the right side was a large oblique inguinal hernia which had filled the scrotum. In the position of a direct inguinal hernia, on the right side was a lobulated mass of fat that contained a peritoneal sac which was closed where it joined the parietal peritoneum as evidenced by a distinct cicatrix. There was a similar mass of lobulated fat in the right crural region which was continuous with subperitoneal fat, but contained no peritoneal sac. There was a crural rupture on left that had some fat connected with the sac.

Case VIII.—Sir A. Cooper saw a case in which a "Steatomatous" tumor in a woman was located in the situation of a crural hernia. It appears that a crural hernia had been gradually obliterated by the growth of a fatty tumor of considerable size.

Case IX.—Fardean (Sédillot's *Journal de Médecine*, vol. xxiii, 1812) saw a case in a man aged sixty-five, who had three fatty herniæ, as follows: One near the ensiform cartilage, one at the umbilicus, and the last one associated with the left spermatic cord.

Annandale states that "Morgagni, Pelletan and Cloquet observed cases of this kind, in some of which there was a small empty peritoneal sac."

Case X.—Mr. Cook (*Med. Chir. Transaction*, vol. vii) reported the case of a married woman twenty-seven years old who presented symptoms of obstruction from a small tumor in the left crural region. It was very tender and irreducible and existed nine months. Operation showed it to be a hard lobule of fat that contained an empty sac.

Cases XI and XII (Cock).—He also refers to two other cases which had a small tender protrusion of the linea alba which probably originated from the subperitoneal fat.

Dr. Annandale saw a case with Dr. Chiene, a woman who was suffering with a painful fatty protrusion situated at the outer edge of the rectus muscle, and was the size of a small mushroom. After some weeks it returned into the abdominal cavity.

Case XIII (Annandale).—Dr. Annandale in June, 1867, saw a Mr. F., aged sixty-five, who suffered with symptoms of strangulated hernia. Dr. Bum was the attending physician. The patient had a femoral hernia on each side. The one on the left had been irreducible for many years and was of thirty years' standing.

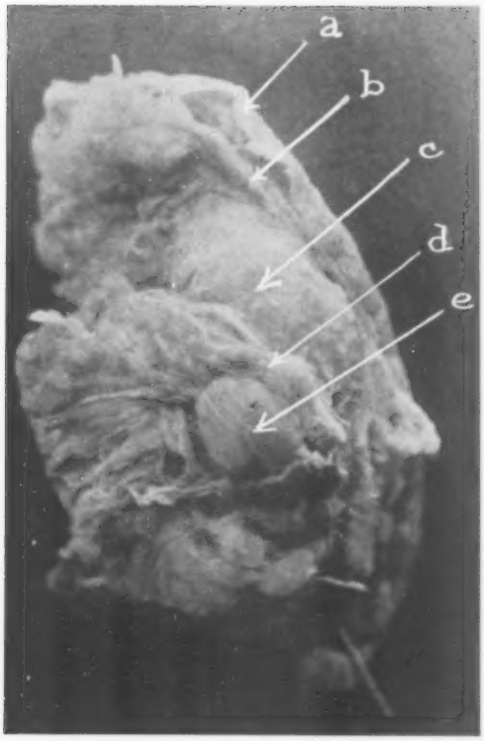

FIG. 1.—View of the umbilical region from inside. *a*, skin; *b*, superficial fascia; *c*, fat tumor external to superficial fascia; *d*, cut edge of linea alba; *e*, lobule of subperitoneal fat continuous with the tumor *c* through an aperture in the linea alba, *d*; no peritoneal sac.

The other one was reducible. Vomiting of fecal matter led Annandale to operate the left side. A transparent shining membrane (the femoral sheath) was opened and contained a mass of lobulated fat the size of a pigeon egg which seemed to extend up into the abdominal cavity. Division of Gimbernat's ligament and an attempt to reduce the mass which was supposed to be omentum caused a distinct gurgle of a portion of gut returning into the abdomen. The mass was ligated for omentum and removed. Careful examination showed it to contain a sac. Good recovery.

CASE XIV (ANNANDALE).—Dr. Annandale was asked by Dr. Niven to see a woman aged seventy-eight years who was suffering from strangulated hernia for three days; it followed a sudden slip. She had had a small irreducible lump in right groin for several years. The tumor was the size of a walnut and was very tender and irreducible. At operation a lump of lobulated fat was found in what was at first thought to be a true sac. The mass had a true neck passing down from the abdominal cavity and was firmly grasped at the femoral ring. Annandale thought it was omentum and was on the point of returning it after cutting Gimbernat's ligament when he remembered his former case. A sac was found in the centre of the mass which contained a congested gut. The latter could not be reduced on account of stricture at the neck of the sac. When it was cut, the bowel was easily reduced. Patient made a good recovery.

CASE XV (Dr. FIFIELD'S Fatty Hernia, *Boston Medical and Surgical Journal*, vol. 97, 1877. Attention was first called to this subject by the writings of Cruveilhier and M. Bernutz).—Dr. Fifield reports the following case: The patient, a man, had been forcibly ejected from a house during a fight, and had been jumped upon and pounded. A tumor was noticed near to and above the umbilicus. It had been considered a ventral rupture strangulated. Dr. Fifield, however, on seeing it, at once recognized a "fatty hernia" and cutting down on the tumor showed that the diagnosis was correct.

CASE XVI.—F. J. LUTZ, M.D. (in the *St. Louis Medical Journal*, vol. lvi, February, 1889) reported a case of "Fatty Tumor Complicating Femoral Hernia." Operation showed a pedunculated fatty tumor attached to the inside of femoral sac. It was three inches in circumference and microscopic examination showed it to be composed of fat.

December 10, 1912, Dr. Joseph Ransohoff read before Southern Surgical and Gynecological Association, Old Point Comfort, Va., a most valuable paper on "Fat Hernia," published in *Lancet Clinic*, January 4, 1913. Seven cases in all were reported from his long and extensive surgical practice, "and curiously enough only two of these were of the femoral type."

CASE XVII (RANSOHOFF).—Mrs. N., aged forty-three, entered Jewish Hospital December, 1894. Had irreducible hernia on right side of two weeks' standing. Patient was very slender. There is an ovoid tumor, lobulated and the size of a small hen's egg. It can be traced to the femoral ring. Impulse on coughing. Operation showed mass to be a subperitoneal lipoma that had passed through the crural canal. It had a well-marked pedicle fairly vascular but no peritoneal protrusion. Three years after, following sudden strain, patient developed a similar tumor of left femoral canal, no peritoneal sac.

CASE XVIII (RANSOHOFF).—Miss J. G., aged twenty-one, entered Good Samaritan Hospital, January 16, 1906, for right femoral hernia supposed. Six months before, patient had tumor in same region that could not be reduced, fever and obstructive symptoms followed. Operation performed to relieve the same. What was done then could not be determined. Two months following operation, tumor appeared suddenly and increased gradually in size.

Present Condition.—Beneath a recent scar in right groin is a tumor the size of a small peach which can be in a large measure reduced. Impulse on coughing. Operation showed a fat hernia that possessed a central funnel-shaped sac which would only admit a probe. The author follows with an opinion as to how the second condition was brought about.

"It is curious that the onset of these hernias is often unnoticed until an accident attracts attention to them. The following case is an illustration."

CASE XIX (RANSOHOFF).—O. J. F., aged twenty-eight, dining-car man, fell violently in a train accident. Pain was experienced in both groins. Three days after examination showed what seemed to be an indirect inguinal hernia on each side. Had a well-developed adipose layer. Tumors were size of a small peach and seemed partly reducible. Would recur without effort on the part of the patient. Impulse on coughing.

Operation under gas-oxygen anæsthesia, September 30, 1912, revealed a lobulated and encapsulated mass of fat on right and left side the size of a small peach, on the inner side of the cord and extending under the aponeurosis of the external oblique, terminating in a small pedicle. There was a small tongue-like sac extending through the centre of the mass. A small probe could barely be passed through it into the peritoneal cavity.

CASE XX (RANSOHOFF).—Mrs. L. B., aged twenty-seven, married five years, never pregnant. Two months before admission to Jewish Hospital, noticed a slowly developing, painless tumor in the left groin.

Physical Examination.—"The patient is a slender woman and presents nothing abnormal except the local condition. Occupying the right inguinal canal and extending slightly into the labium majus is a pyriform solid tumor the size of a small pear. To the touch it is lobulated and gives the impression of an omentocele. There is an indistinct impulse on coughing, and the tumor can be partly pushed back into the enlarged canal. The operation at the Jewish Hospital, February 8, 1907, for a supposed irreducible inguinal hernia revealed a nicely encapsulated subperitoneal lipoma on the outer side of the round ligament. Through its centre there ran a process not larger than a broom straw.

CASE XXI (RANSOHOFF).—Father H., aged sixty-four, February 10, 1909. Patient has had a right inguinal hernia for three years. It has been slow of development and painless, except when truss was worn.

Physical Examination.—Patient has a distinct tendency to obesity. In right inguinal canal and upper part of scrotum is a firm, rather smooth mass, as large as a peach and presenting a distinct impulse on coughing. The patient can apparently reduce the mass, but it can then be felt by the top of the examining finger.

"Operation, February 11, 1909, reveals a perfectly encapsulated subperitoneal fat tumor on the outer side of the cord. It is easily shelled out, but at its base there are running into it some quite large vessels. In the bed of the tumor there is exposed a circular area of the reverse side of the peritoneum, one inch in diameter, without any protrusion whatsoever, and moving distinctly with respiration. The operation was completed as an ordinary hernia."

CASE XXII (RANSOHOFF).—Miss F. P., aged thirteen, referred by Dr. Forcheimer. Patient felt a sharp pain in right groin and on examination the next day a tumor the size of a pigeon's egg was discovered. She was certain that it came on suddenly.

Present Condition.—Patient is very slender. "Projecting from the right inguinal canal is a tumor, like a pigeon's egg in size and shape. It is slightly movable, quite tender to the touch and irreducible. There is no impulse on coughing. Believing it to be a hernia, an immediate operation was performed at the patient's home, June 6, 1907.

"The operation revealed an encapsulated fat hernia with many fibrous strands

running through it. The vessels on the mass were greatly injected, and at its upper end there was a marked constriction, which accounted for the condition and the onset of the acute symptoms. No trace of a peritoneal protrusion could be found."

CASE XXIII (RANSOHOFF).—C. R., aged forty-nine, admitted to the Jewish Hospital, April 15, 1910. For many years he had had a right inguinal hernia for which he has worn a truss. For the last two years, however, he has not worn a truss, because of the pain which it caused and because the hernia did not seem to get any larger. The patient is a very fleshy man with an irreducible right inguinal scrotal hernia. It is the size of a good-sized peach with distinct impulse on coughing. The operation revealed an indirect inguinal hernia. Nothing unusual presented until the sac was opened, when there was found within it a lipoma as large as a small peach and attached by a broad base. The sac itself was like the finger of a glove and readily tied off. The operation was completed by the Bassini method.

Ransohoff describes a case of fatty epigastric hernia, the size of a plum. Case entered the Cincinnati Hospital service of Dr. Kramer. Patient was found delirious at home. Six months previous he had been in the hospital for acute nephritis. At operation the tumor was strangulated by a sharp ring formed by the margin of the recti muscles. No contents. Patient died in four days of chronic Bright's disease.

Ransohoff makes mention of a case reported by Wendel (*Zeisch. f. Chir.*, vol. 65, p. 388) in which fat tumor of the femoral region was strangulated by torsion. A fine process of peritoneum was found within the tumor.

CASE XXIV.—The following case is offered by the author, first because it represents a rare complication of an apparently rare condition; second, the anatomical relation being classical in this case, caused the author to be puzzled like a few of the previous writers.

My assistant, Dr. Elizabeth Shrieves, was called to see Mrs. L., aged seventy, widow, on Saturday, November 17, 1917, at one-thirty P.M., and from the patient obtained the following history: On Friday, November 16, 1917, the patient, late in the afternoon, helped her daughter lift a tub of dirt. She experienced a sudden pain in the region of right groin. After this she hoed in the garden for a short time but had to give it up on account of the pain.

She grew worse and Saturday, after dinner, Doctor Shrieves found her confined to her bed and complaining of extreme pain in right groin. Patient was vomiting and continued to vomit the rest of the afternoon. The doctor forgot to record the pulse and temperature. On examination a very hard, tender tumor the size of a small hen's egg was situated in the region of a femoral hernia on the right side. The doctor's recollection was that there was no impulse on coughing. She did not employ taxis but instead used hot and cold applications with the patient's hips elevated. She made three trips that afternoon to see the patient, and at eight P.M., when I was called to operate, the tumor had not been reduced. I did not take time to examine the patient because of her critical condition. The patient's previous history is of interest. She came to America from Cork, Ireland, when she was aged twelve. At the time of her immigration, she was carrying from two to four gallons of milk on her head daily over a milk route four miles long.

The patient has always been constipated; never had any serious illness. Has had frequent pain starting in right axillary line at costal margin and radiating down to the inguinal region on the same side. She never noticed a lump before in her groin. She has experienced the radiating pains for forty years or more.

Patient is slender, very frail, and possesses very little subcutaneous fat.

Operation at home; under ether anæsthesia. I palpated a solid tumor in right crural region; it was very prominent. A vertical incision was made over the tumor dividing the skin and subcutaneous tissue. This revealed a tar-black mass projecting through saphenous opening and situated within a thin transparent sac which was supposed to be the peritoneal sac of a femoral hernia. We had just come from the hospital where I operated on a lady of the same age for a strangulated femoral hernia on the right side. The femoral sac in this patient contained a gangrenous bowel, which we resected, which on inspection presented an identical appearance to the above case. I said to Doctor Shrieves, " Here is another bowel to resect," but on opening the thin sac I discovered that the mass was not bowel, omentum, bladder or any abdominal organ that I had ever seen. It was lobulated and had a shiny surface though black, and was apparently attached to the margins of the femoral ring where it formed a narrow neck. Like Annandale, I was puzzled, even more than he because I at once recognized that I was not dealing with any part of an intra-abdominal organ, but still there was a strangulated mass the size of a hen's egg apparently situated in a peritoneal sac that I must recognize and that quickly. I decided to *divide Gimbernat's ligament.* This I did by introducing the index finger of the left hand into the femoral ring the best I could and dividing the ligament with a pair of straight Mayo dissecting scissors. This solved the mystery, for, when I withdrew my finger, out slipped the vermiform appendix through the opening I had made in the true peritoneal sac at the femoral ring. The strangulated mass was a fatty tumor surrounding the peritoneal sac. The appendix was easily removed and showed no evidence of acute inflammation, therefore I do not believe that it was in the femoral sac at this time although, no doubt, it had frequently occupied this position. Microscopic examination of the appendix showed that the lumen was obliterated. The radiating pain of long standing might have been caused by irritation or pulling of the appendix while it was in the femoral sac. The thin transparent femoral sheath is the thing that has fooled us all. In my case it seemed to be identical with the femoral sac. The tumor was ligated and removed and the operation completed in the usual way. The patient made a good recovery, union was by first intention and she is enjoying good health, 1919. The radiating pain complained of for so many years stopped after the operation, and her constipation has been relieved.

Case XXV.—While preparing this paper, I operated upon a case of fatty hernia of the umbilical region that I had seen in consultation

with Dr. G. W. Wire on Thanksgiving day, 1918. At that time I made a diagnosis of umbilical hernia that contained an adherent piece of omentum. When the patient came in for operation, I reëxamined her and found just above the umbilicus a tumor mass about 2 cm. in diameter. There was no impulse on coughing, although the umbilicus itself was pouched out, the mass was not painful or tender and had been discovered by Doctor Wire while making a general physical examination of the patient. She is the mother of eight children, rather frail, there is small amount of adipose tissue, aged forty-two. A transverse incision surrounding the umbilicus was made and that region removed. There was no peritoneal pouch and the mass consisted of a lobule of fat that had passed through the linea alba just above the umbilicus (see Fig. 1). A small portion of the lobule could be distinguished from the internal surface of the linea alba. The operation was completed by Mayo's technic. Patient made a good recovery.

The differential diagnosis of Carsten Holthouse, the English authority, as quoted by Fifield, will be of interest at this point to show that we must change our views as new facts are added to the subject at hand.

(1) They are of slow growth and come on without obvious cause.

(2) Their growth and increase of bulk are progressive, never larger at one time and smaller at another.

(3) When pinched up between the fingers, they are of lobulated, dimpled appearance.

(4) When lifted off the parts below there is no impulse on coughing.

(5) They are never reducible.

After a careful study of the foregoing cases, the following summary is offered.

1. Can be located in region of indirect inguinal hernia, in femoral region, linea alba or linea semilunaris.

2. They are gradual in development but onset of symptoms may follow a sudden exertion or injury and the patient first notices the tumor at that time.

3. May or may not have a peritoneal sac. The latter is usually small and empty but can have contents of ordinary hernias.

4. Fatty tumor can be on either the inside or outside of the sac if the latter is present.

5. Can become strangulated with an empty sac or even without a sac, and with or without torsion.

6. An impulse on coughing has been observed, but is generally absent.

7. False reduction in some cases is possible.

8. Diagnosis seems to be difficult.

9. Treat the same as an ordinary hernia.

ANURIA AFTER UNILATERAL NEPHRECTOMY*

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At the 1914 meeting of the Southern Surgical and Gynæcological Society at Asheville, N. C., I reported five cases of anuria due to unilateral calculous obstruction, and discussed the subject from several viewpoints. In this paper I desire to record an additional case of anuria with an entirely different causative factor and which terminated fatally.

Miss E. T. came under observation in 1912, and again in June, 1915. The family history was negative for carcinoma, tumor, tuberculosis, insanity, etc. Father and mother living and in good health, as are two brothers.

Previous History.—At five years of age she had tuberculosis of the right hip, which, treated by Dr. V. P. Gibney, of New York, resulted in ankylosis of the hip and shortening of the right leg. At the age of seventeen a psoas abscess developed, from which she made a recovery. Later labial abscesses were present. Menstruation was always very painful, and for this the cervix had been dilated and a curettement done. Since childhood the patient has had pain over the appendiceal region, and at one time was sent to the hospital for operation, which, however, was not done. This pain has since been attributed to hypertrophy of the abdominal muscles.

For the past two years she has complained of extreme nervousness and has had attacks of hysteria. There have been numerous attacks of urinary retention requiring catheterization, large amounts of urine, however, being always found in the bladder. The bladder has been irrigated upon numerous occasions during the past two years, and, following cystoscopic and radiographic examination, the right kidney pelvis was repeatedly washed with collargol solution. The appetite has been poor, and she has in two years lost forty-six pounds.

Physical Examination.—Heart, lungs, liver and stomach normal. Abdomen soft; no masses felt, nor is there tenderness anywhere. Right hip ankylosed, the right leg much atrophied and three inches shorter than the left. Temperature 99.3° F., pulse 100, respirations, 20.

Urinalysis: Amber color, specific gravity 1004; acid reaction, albumin positive. There is a large amount of pus, no leucocytes, red blood-cells nor casts; few squamous epithelia.

Radiographic Examination.—Lungs and heart normal. Right kidney displaced downward; no renal calculi or other shadows. Pyelographic; right kidney displaced, low-lying, pelvis opposite fourth lumbar vertebra. Ureter normal in shape and position. Left kidney normal in position; ureter normal in shape and position.

* Prepared for the Southern Surgical Association Meeting, Baltimore, December, 1918.

Cystoscopic Examination.—Bladder wall normal except in trigonal area. Here and at neck the vessels are enlarged and tortuous; trigone much reddened. Right ureteral orifice slightly distorted, swollen, some small punctate hemorrhages about it. Left orifice normal.

Indigo-carmine intramuscularly excreted from both kidneys about the same time, *i.e.*, about eight minutes. Phenolsulphonephthalein test —first hour 35 per cent., second hour 18 per cent. Left kidney urine, occasional pus cell only; right kidney urine, large amount of pus. No tubercle bacilli found microscopically in urine from either kidney nor in combined urines as obtained from the bladder which contains numerous organisms.

Guinea-pig inoculation: At the end of three weeks animal inoculated with centrifugalized urine from right kidney is much emaciated and autopsy shows gross lesions of tuberculosis involving spleen, liver and lymph-nodes in omentum in region of stomach. Smears made from these lesions showed a beaded acid-fast organism. Control pigs and one inoculated with urine from left kidney show no lesions suspicious even of tuberculosis. Diagnosis: Right renal tuberculosis.

Operation (July 1, 1915).—Nephrectomy, right kidney, under nitrous oxide gas-oxygen anæsthesia. Examination of kidney removed reveals "in the substance of the kidney a few miliary translucent nodules. There is present also a rather large caseous mass about 1 cm. in diameter near the pelvis. The ureter is distinctly thickened and involving the pelvis the lesion is uniformly distributed. Microscopically numerous typical miliary tubercles with giant-cell formation and epithelioid cells. There is also marked round-cell infiltration. Microscopical diagnosis: Tuberculosis of kidney" (Baldauf).

The patient's temperature night before operation was 100° F.; pulse 102; morning before, 99.2° F.; pulse, 108. She was returned from the operating room at 10 A. M. and given morphia sulphate ⅛ grain. At my evening visit at 6 P. M. temperature 100 ° F., pulse 118; and the chart showed only two ounces of urine containing blood. She was immediately catheterized and four ounces of clear urine obtained. Saline proctoclysis was ordered. Twenty-four hours after the operation there had been no further excretion of urine, though twelve hours later one ounce of bloody urine was obtained.

Kidney decapsulation was advised but refused. The usual remedies were given, the loin cupped, etc. A catheter was introduced into the left kidney pelvis and warm saline lavage instituted. This resulted in the secretion of a few ounces of bloody urine, but with this one exception no further urinary secretion occurred until the nineteenth day, when one and a half ounces were voided. On July 20th several drachms were obtained by catheter.

Refusing repeatedly and constantly any further operative measures, with a full knowledge of the otherwise certain termination, the patient lived for twenty-six days, dying quietly without pain, conscious to within a very short time of her demise.

In reviewing the bedside history of this case there are several interesting points to which I would briefly like to call attention. This patient had been

having elevation of temperature for certainly a considerable period before entering the hospital, which elevation was maintained post-operative for three days. The temperature on admission and for several days before the operation was 101° F. The day following the operation the morning temperature was 99.2° F., evening temperature 100.2° F. On the second day the highest temperature was at noon, 99.4° F. On the third day the temperature receded to normal and remained so throughout the entire course until just before death of the patient, when it registered 102° F. axillary. The previous day the temperature had been normal. A small drain had been placed in one angle of the incision; this was removed on the fourth day, the wound healing primarily; and at the time of the patient's death no dressings had been worn for several days.

A study of the pulse and respirations might also be of some interest. The pulse following the operation was 110, rising to 120 that evening and remaining about the same for twelve hours. On the second day the pulse receded to 104; the third day it was from 76 to 88, and remained about the same until the sixth day, when it varied from 80 to 100. This range was maintained with some slight variations until six days before the patient's death, at which time it began to gradually rise, the highest point reached at any time being 130, but never under 100. The volume, which was good at first, became very much less a few days before death.

The blood-pressure was 112 mm. Hg at the time of operation. On the fifth day it was 100, the seventh day 105, the ninth day 119. It did not vary markedly from this, the reading ranging from 116 to 120 until within the last few hours, when it gradually became lower.

The most marked effect of cessation of the urinary secretion seemed to be upon the respirations, which were reduced within forty-eight hours to 16, then to 14, remaining 12–14–16, both waking and sleeping, until the nineteenth day, when they were read as 8; on the twentieth day as 6; varying between 6 and 8 during the remainder of the patient's life until twenty-four hours before death, when they reached 18, remaining between this and 24–26 to the end.

A study of the blood urea was impossible on account of the opposition of the patient and her family to making repeated records. However, seven days after the operation there were eighteen parts of urea in ten thousand, an estimate of 83 milligrammes of urea in 100 c.c. of blood. Twelve days later this had risen to 172 milligrammes of urea nitrogen per 100 c.c.; and about four days later this was increased to 200 c.c. No further blood was had for the reasons stated. It would have been interesting to have kept an accurate record of this condition.

The bedside chart reads that there was no nausea immediately following the operation, but the patient began vomiting eight hours after she was placed in bed, and without any cessation this vomiting was continued four or five times daily until her exit. The vomitus consisted of bile-stained fluid at first; later it began to contain some undigested food particles; and

the day before death it became brown in color, contained blood, and had a very offensive odor.

Alvine evacuations occurred every day, and were at times very thin and offensive, probably due in part to the administration of purgatives in an effort to maintain elimination through the intestinal tract. For several days, from about the fifteenth until the twentieth day after the operation, considerable blood was passed by the rectum and a great deal of mucus. During this time no purgatives were given. The patient was able to take nourishment constantly, there was never the slightest mental disturbance, her mind being perfectly clear until within twenty-four hours of death. She slept well every night, had her daily bath; there was no twitching, no headache, no visual disturbance; in fact, she seemed normal in every way so far as her appearance was concerned from ordinary physical observation.

On the twenty-second and twenty-third days she hiccoughed quite frequently during her waking hours. She was out of bed daily for variable periods of time, being up in a roller chair and at times walking about the room from the twelfth day until twenty-four hours before her death. The patient, of course, necessarily was much perturbed on account of her inability to pass urine, and would become very much excited and nervous and at times would talk of it constantly, so that it was difficult to get her to sleep. Because of this she was given occasional doses of morphine or veronal at bedtime. There were never any convulsions or any evidence other than that found by blood examination of urea retention.

In reporting this case in such detail we do so with the idea of eliciting some discussion, particularly as to the cause of this occasional sequel of nephrectomy. Numerous cases have been reported in the literature where suppression varied from a day or two to as much as eight or ten days; and if I mistake not Morris cites a case of thirty days' duration.

It might be that this case should not be classed as one of complete anuria, as a little urine was voided upon several occasions during the patient's illness. The tolerant stage, however, in this case resembles in its duration that which we have with calculous anuria, though some of the symptoms which we have observed in calculous anuria were not present in this individual.

We are still of the opinion that not only in calculous anuria, but in the occasional suppression which follows nephrectomy, the suppression is brought about entirely through circulatory disturbances. We think that the term reflex anuria indicative of some nerve connection or nervous reflex is a misnomer. Our studies some years ago in ureter ligation showed a compensatory vascular activity in the kidney with the open ureter. In every instance the afferent vessels became overfilled with blood. The efferents can only contain a certain amount of blood, and we have happening here just exactly what happens in a *stampede* of a crowd at a theatre fire. A few get out, but the large mass (the blood on the afferent side) is held back.

We believe it is this active arterial congestion, this vascular overfilling, particularly on the arterial side, which accounts for the diminution in the urinary output in practically all cases of unilateral nephrectomy during the first few hours. As soon as the circulation on both sides in the kidney is equalized, then we have an increase in the urinary output and the kidney gradually accommodates itself to performing the function of both organs.

We would again offer circulatory disturbances as the explanation of anuria not only in this case but in those due to unilateral calculous obstruction.

ADHESIVE PLASTER METHOD FOR THE RAPID REGENERATION OF SKIN OVER GRANULATING WOUNDS

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The simplicity of this procedure and its effectiveness prompt me to publish it. It has, moreover, an extensive application. It may be applied in all types of granulating wounds, whether these be due to ulceration, burns, or trauma, and especially wounds produced by surgical operations. Perhaps the most important field for this method is found in the demand for skin regeneration over denuded surfaces produced in the skin sliding operation. This method is now widely employed in the treatment of the apparently hopeless cases of chronic suppuration of bones and joints, empyema, and lung abscess. It is mainly for such cases that the method here is described.

Method of Application.—The technic consists in applying strips of plain or zinc oxide adhesive plaster along the edges of the granulating wound. These strips, one-half to three-quarters of an inch in width, must be so adjusted that they cover both margins, that of the skin and that of the granulating wound. This leaves the centre of the granulating surface exposed for absorption of the wound secretions by a dry sterile dressing.

Twenty-four hours later the dressing and adhesive plaster are carefully removed. It will be found that along the margin of the skin there has now formed a bluish-gray border, about 2 or 3 mm. in width. This bluish-gray border represents the new growth of epithelial cells.

The wound is now dressed with dry gauze, which is left on for twenty-four hours, followed on the next day by another application of adhesive plaster. This procedure is repeated until the entire granulating surface is covered with an epithelial growth.

All necrotic tissue must be allowed to slough off, so that the base of the wound is clean, before we can expect the epithelium to grow. The wound must never be rubbed with gauze, as this would be apt to destroy the new epithelial cells.

A mistake which is frequently made is to draw the surfaces together with the adhesive strips. This is not the intention. On the contrary, the wound edges should be kept apart as much as possible, so that the skin may grow along a flat surface. When the skin grows into very deep recesses, so that the skin surfaces are in contact, we are likely to produce a pocket in which the skin secretions would accumulate and undergo decomposition, thus causing a bad odor. To prevent this, we must plan our operations so as to produce a funnel-shaped depression which can be properly ventilated.

The adhesive plaster method of treatment suggested itself to me when, in 1910, I watched its effects in treating extensive burns by one of our assistants, Dr. S. Kositchek. He applied the adhesive plaster on electric burns of second and third degree (caused through setting fire to the clothes) which often extended over the entire chest or back, and with proper application of this method, these surfaces gradually became covered with what appeared to be a dry, normal skin.

Adhesive plaster was already used twenty years ago in the treatment of chronic ulcers, as is stated by Doctor Jackson, of Kansas City, in his discussion of my paper in 1916, when I brought this matter up in Omaha in connection with the treatment of chronic osteomyelitis by the skin sliding operation. He stated that this method of treatment may have a much wider application but that Dr. Carter Cole, of New York, had already used it twenty years before.

Many substances have been used to stimulate skin regeneration, such as balsam, acacia and paraffin and scarlet red. None, however, fulfilled the requirements as has the adhesive plaster. Its action is largely mechanical, as explained in an article written by Dr. Charles A. Parker in the *Journal of the American Medical Association*.

Explanation of the Rapid Epithelial Growth.—The reason why large granulating surfaces have no tendency to be covered by epithelium until skin grafts are used, is this: The granulation tissue grows much faster than the epithelial growth and thus we find that the granulating mass overlaps at the margin of the wound. In other words, the granulating mass is much higher than the skin level. The epithelial growth stops at this margin because it cannot grow upwards over the elevated granulating surface.

In order to overcome this obstacle we must establish a level surface, merging from the skin over the granulating surface, and this is accomplished by pasting adhesive plaster over the margin. It keeps the granulations from rising any higher than the skin and this gives the epithelium a chance to regenerate underneath the surface of the adhesive plaster. The epithelial cells will grow rapidly under these favorable conditions and cover as much as one-quarter inch in twenty-four hours all around the wound, which is plainly visible by the appearance of a bluish-gray border. The under surface of the adhesive plaster acts as a path for the regeneration of the cells, on the same principle as the vine would grow along a string or wire and cover within a short period the entire wall of a building. If the strings were not there the vine would grow in all directions. It is the string that keeps it close to the wall, and so with the adhesive, the adhesive furnishes a trellis for the growth of the epithelial cells.

This explanation of the growth is not entirely theoretical, it is based upon experimental study on animals and more extensively on the human. The microscopic examination of specimens cut out for this purpose from

healing wounds has proven this beyond doubt, and I desire to present some of these microscopic sections.

For illustration I exhibit a schematic drawing, Fig. 1, which is self-explanatory.

I have employed the adhesive plaster method in over 100 cases, with the most surprisingly beneficial results. For illustration, I wish to cite but a few cases, the illustrations of which will speak for themselves.

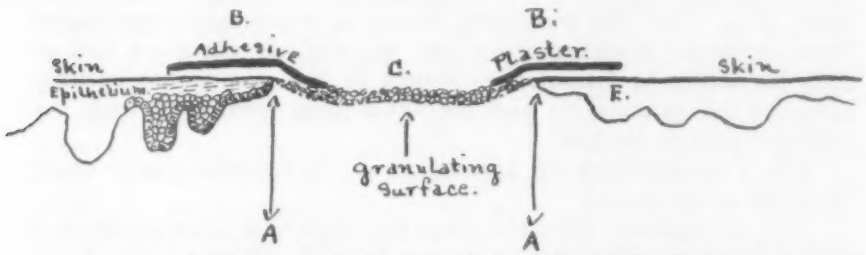

FIG. 1.—*AA*, margin of epithelium bordering on granulating surface. *BB*, adhesive plaster covering both margins, skin and granulations. *C*, exposed granulating surface.

CASE I.—*Microscopic Section of Skin Removed from a Lung Abscess, Three Years after Operation.*—A young man, twenty-four years old, with an abscess in his lung for nearly six years, due to the inhalation of a pin-tack, was operated on by me in 1908. The pin-tack was removed but the abscess would not heal, since it had seven small openings communicating with bronchi.

I decided to make a skin sliding operation in 1914, to expose all these bronchi and cauterize them with the actual cautery for the purpose of obliterating them. I was, however, unable to obliterate all seven bronchial openings because three of them were so located that I could not introduce the cautery into the openings.

I, therefore, decided to resect more ribs, to make these bronchi accessible to treatment. In doing so I was obliged to resect some of the skin, Fig. 2, which had grown into the deep recesses of this lung abscess by means of the application of adhesive plaster.

From this newly formed skin I made microscopical sections, which showed distinctly the regeneration of the epithelium very nearly that of normal skin. There is a distinct basement membrane between the connective tissue of the outside and the epithelial layer, Fig. 3. There is no evidence of any glands, however, and in this respect this newly formed skin differs from the normal. But for practical purposes the skin surfaces so covered are usually dry and fulfill the requirements of normal skin for covering wound surfaces. At any rate, it is the best substitute for normal skin, for it has no tendency to contracture. In the older cases we can lift up this skin from its base, just as we can normal skin, which we cannot do with old scar tissue.

CASE II.—*Osteomyelitis of Ribs and Destruction of Right Costal Arch.*—J. K. age forty, male. Three years ago (1915) developed a swelling and pain in the right costal arch. The swelling was opened

and pus found. Did not heal, however; the wound kept on discharging for two years and then patient consulted me. Examination revealed three discharging sinuses in the right costal arch, one at the level of the mammary line, at about the eighth rib, the other two near the costal margin. Bismuth was injected through the upper opening but came out through the two openings lower down.

Operation on June 11, 1918, consisted in the resection of the entire right costal arch and two inches each of the eighth, ninth and tenth ribs. The skin overlying this area, which had degenerated from persistent discharging sinuses, was entirely cut away and an area six inches in diameter, as shown in Fig. 4, was left entirely denuded for granulation and for subsequent treatment with the adhesive plaster method.

Fig. 5 demonstrates the application of the adhesive plaster along the edges of the wound.

The regeneration of the skin from the edges took place rapidly and within two months the entire area was covered with skin. Fig. 6.

Case III.—*Skin Sliding Operation for Empyema.*—Young man of twenty-six, who retained a fistulous empyema subsequent to a pleuro-pneumonia six years previous. The case had the usual history of resection of one rib and drained with no tendency to permanent closure.

A skin sliding operation was performed in June, 1917. Fig. 7 illustrates the skin flap in the wound, after the resection of the rib, and exposure of about 3 or 4 inches of granulating surface from which the implanted skin had been denuded. At this stage about one-half of the denuded surface is already covered with newly-formed skin; six weeks later the entire denuded area was covered with newly-formed skin, the funnel-like depression and the entire tract down into the pleura. The wound is perfectly dry and the skin is movable from its base. Fig. 8. For illustration of the adhesive plaster in empyema cases, I illustrate Fig. 9, which shows the strips of adhesive plaster dipping down along the edge of the resected ribs and covering the under surface of the costal pleura.

In the empyema cases the application of the adhesive plaster is a little more difficult, but with proper care it can be carried out with success.

Case IV.—*Osteomyelitis of Femur with Skin Sliding.*—The case here illustrated represents a type of chronic suppuration of the femur not very uncommon. It has existed for about fifteen years. All previous operations and also the bismuth treatment had been found ineffective, because it was discovered that the shaft of the femur up to the middle was filled with sequestra and pus. The knee-joint was also affected.

The skin sliding operation was performed in 1917. Figs. 10, 11 and 12 illustrate the progress of regeneration of the skin over the denuded surfaces. In Fig. 10 we note that the greater part of the quadriceps muscle is exposed and also a great part of the gracilis muscle. The skin dips down into the depth of the excavated

femur. Fig. 11 illustrates the condition two weeks after the operation. Granulations have now formed over the entire surface and skin is beginning to form along the margins.

In Fig. 12 the entire surface is now covered with skin, no discharge present.

Patient, later on, had some operations below the knee, which were treated in the same way and with equally good result. He is now back at his work, a plumber.

CASE V.—*Osteomyelitis of Femur. Skin Sliding.*—Illustrates the procedure in a case of osteomyelitis of the femur near the hip. A skin flap is prepared during the incision, which is to dip down into the recess formed by the removal of the diseased bone in the femur. Without using any suture, the tip of the skin flap is tacked down temporarily into the bone, as shown in Fig. 13 and the entire surface is left exposed. In Fig. 14 we note the process of healing and in the picture we see the clear margin of the new growth of skin between the true skin and the granulating surface. In Fig. 15 the entire area is now covered with skin.

The photographs give the impression that the healed area is scar tissue. This is not the case, this photographic effect is due only to the difference in color of the skin, for this new-formed skin is movable and on microscopic section proves to be composed of epithelial structure.

CASE VI.—*Tuberculosis of Fascia Lata and Muscles.*—This represents the progress of an operation for tuberculosis of the fascia lata and underlying muscles.

A nurse, thirty years old, had previously had six operations for this condition without any result, the entire surface draining from many points of the old incisions and scars.

In Fig. 16 we see the condition right after the second operation, the dark part is the granulating surface after the operation performed previously, the part marked "B" had been denuded four days previously. Here we had an exposure of about a foot in length and about 8 inches in width and about 2 inches in depth.

The adhesive plaster method was used here and eight weeks later the epithelial growth progressed to the point illustrated in Fig. 17. A month later it was covered to the size illustrated in Fig. 18. There is no discharge and the nurse is back at her work.

CASE VII.—*Ulcer of Leg Unresponsive to Skin Graft, treated with Adhesive Plaster Strips.*—Illustrates an ulcer of the leg in a young man which had existed for some five years, with no tendency to healing, as shown in Fig. 19. We made several experiments in this case to cure this persistent ulcer. We cut away an area of about three inches in diameter, clear to the border of the true skin and then made a transplant of skin from the thigh, as shown in Fig. 20. This, however, sloughed out, as shown in Fig. 21. We now tried Thiersch grafts, but these also sloughed away. There seemed to be no tendency in the base of this ulcer for nourishing any skin graft or skin transplant. Thereupon, I tried the adhesive plaster method and suc-

ceeded in regenerating the skin completely within four weeks, as shown in Fig. 22, the patient being able to use his limb, the skin being perfectly movable over the regenerated surface.

CASE VIII.—*Redundancy of Skin Produced by Adhesive Plaster Method in Extensive Burn.*—S. G., a young boy of twelve. Was brought to me at the age of three years with a very extensive burn of his left chest, back and shoulder, as well as the left arm to the elbow, produced by setting his clothes afire. The burn was so extensive that it was advisable to allow the arm to grow on the chest wall, in order to diminish the area for granulation, as seen in Fig. 23.

Two weeks later we began to treat the granulating surface with adhesive plaster from the edges of the burn. Later on separated the arm from the chest wall, continuing the application of the adhesive plaster until the entire area was covered with new skin.

I exhibit photograph, Fig. 24, of the boy in his present condition, at the age of twelve. It shows the entire area covered with movable skin, which can be lifted from the underlying tissues and the arm can be extended in all directions. In fact, he plays the violin without any difficulty.

CONCLUSIONS

1. The adhesive plaster method for regeneration of the skin is the simplest and most effective, and in a great measure supplants the necessity of skin grafting.

2. It is applicable in all granulating wounds, whether they be produced by injury, by disease, or be subsequent to operation.

3. The epithelial covering thus produced is only in appearance somewhat different from normal skin but serves practically the same purpose as a skin transplant.

FIG. 2.—Triangular flap of skin removed from interior of lung abscess three years after operation.

FIG. 3.—Case I. Microscopic section of newly formed skin, removed several months after formation.

FIG. 4.—Case II. Showing granulation surface remaining after resection of costal arch.

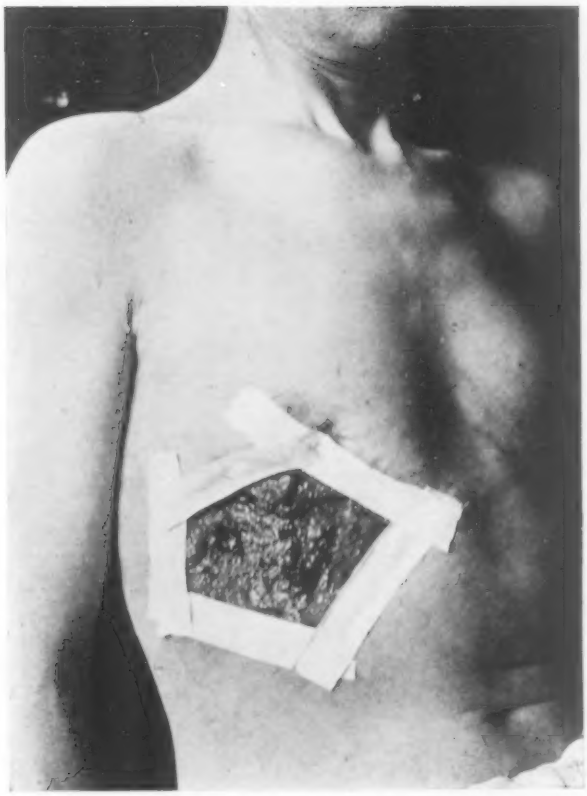

FIG. 5.—Case II. Showing method of application of the adhesive plaster.

FIG. 6.—Case II. End result.

FIG. 7.—Case III. Condition of skin flap two weeks after operation. Granulating surface three inches in width, eight inches long.

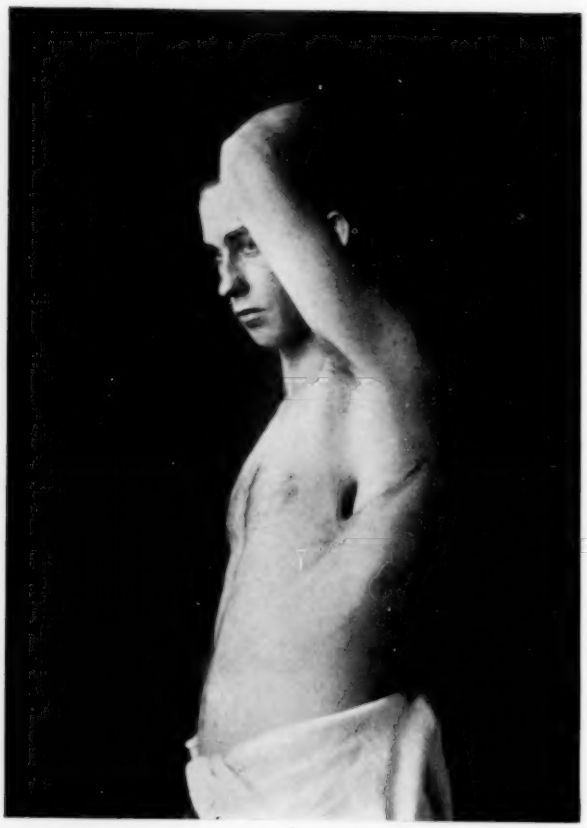

FIG. 8.—Case III. Denuded surface now covered with new growth of skin. Funnel-shaped depression dry.

FIG. 9.—Illustrates the method of applying the adhesive plaster in cases of empyema where the skin sliding operation has been performed. Strips must run beyond the border of the growing skin.

FIG. 10.—Case IV. Condition three days after operation. Note large area exposed for granulation.

FIG. 11.—Case IV. Reduction in size of granulating surface by new growth of skin along edges. Two weeks after operation.

FIG. 12.—Case IV. Skin now covers all but the crevices in the two incisions. No discharge (six weeks later than Fig. 11).

FIG. 13.—Case V. Skin flap tacked into the canal of the femur. No sutures used. Large area left exposed for granulation.

FIG. 14.—Case V. Three weeks later than Fig. 13. Demonstrates clearly the new skin formation along edges.

FIG. 15.—Case V. Complete closure. Entirely covered with new growth of skin.

FIG. 16.—Case VI. Condition four days after second operation. Dark area is granulating surface from previous operation. *B*, surface two inches deep.

FIG. 17.—Case VI. Condition eight weeks later. Margin designated by *a*, new growth of skin.

FIG. 18.—Case VI. Condition four weeks later. Only about two inches square granulating surface remaining for complete closure.

FIG. 19.—Case VII. Condition of chronic ulcer, five years standing, surrounded by unhealthy skin.

FIG. 20.—Case VII. Transplant of skin from thigh sutured to healthy borders.

FIG. 21.—Case VII. Transplant sloughed, leaving denuded surface with unhealthy granulations.

FIG. 22.—Case VII. Result of adhesive plaster method, new skin movable from base.

FIG. 23.—Case VIII. Extensive burn. Upper arm grown to chest, to temporarily diminish granulating surface.

FIG. 24.—Case VIII. Nine years later. Showing mobility of newly formed skin from underlying tissues.

EXPERIMENTAL RESEARCH ON THE EFFECT OF INTRAVENOUS INJECTION OF GUM SALT SOLUTIONS *

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Serious effects have been reported at certain times to have followed intravenous injection of gum salt solution in cases of shock. While it is most probable that such results may have been principally due to improper selection of cases, it was thought possible that other factors than the condition of the recipients may have been involved. Among other possibilities, the chance of the occurrence of anaphylactiform disturbances was considered to be worthy of investigation. Gum acacia, a substance in the colloidal state, might interact with the blood colloids or the surfaces of body cells with the porduction of harmful results.

It is well known that kaolin, agar, Witte peptone, and certain other substances with the properties of surface produce anaphylactic-like phenomena when introduced into the circulations of animals. It was from this standpoint that this work was undertaken. Guinea pigs were chosen as the recipients for the injections, as these animals are known to be the most sensitive reagents for this type of reaction.

Source of Material.—With one exception, all the samples of gum tested were made at the central laboratory. The bottles containing the gum were in every case except one marked with the date of its preparation. All of the material tested had been put up and sterilized in 500 c.c. bottles fitted with clamped tops. All of the preparations contained the standard concentration of gum (6 per cent.) in 0.85 per cent. NaCl solution. The samples were obtained from three sources, *i.e.*, reserve stock, chemical laboratory, storeroom, central laboratory, and from the medical supply dumps at the front. The origin of the material used in the various experiments will be indicated.

It was found impossible to obtain accurate information in regard to the exact raw material used in the preparation of the different samples. In general, the raw material was from three sources, English powdered gum acacia, French powder and the unground "tears." But no record has been kept of the material used for definite samples.

Similar difficulties were met with in trying to ascertain the exact process of preparation of each solution. The degree of heating to bring into solution, the methods of clarification and filtration, and the length of time of sterilization were apparently changing experimental matters of which no clear record was kept. As the investigation has turned out this lack of concise detail was not a serious matter, but in case certain toxic samples had been met with such data would have been sadly missed.

* Submitted, January 7, 1919.

Toxicity Tests on Various Samples. Method of Calculating Dosage.—The preliminary experiment consisted in intravenous injection into guinea pigs of the latest preparation obtainable from the chemical laboratory. Approximately 1/6 blood volume was used as the dose in this experiment. The blood volume of the animals under test was assumed to be approximately 1/13th of the body weight. Consequently the formula-body weight in gms. /13 was used in this and following experiments.

Speed of Injection.—The speed of injection used in these experiments was much greater than that employed in actual application of the gum to shock cases. This was done in order to throw a maximum strain on the resistance of the animal. It is well known that disturbances of the anaphylactic type may be avoided by extreme slowness of injection. Since it was the purpose in these experiments to find out whether under any condition gum could induce reactions of this type it was considered wise to inject at the maximum speed tolerated by the animal. The small and moderate sized doses were injected in 60 minutes, the larger ones, ½ and ⅓ body weight in 90 to 120 minutes.

Technic of Injection.—No attempt at replacement of blood volume was made. The plethora resulting from the injection of large quantities did very little damage, since out of over two hundred animals injected, only three suffered from rupture of some part of the circulation. The solutions were carefully warmed to 42 degrees before injection. Injections were made with Luer syringe into the left internal jugular vein. The guinea pigs were immobilized upon Latapie boards, the neck shaved, iodized and a small oblique incision made lateral to the median line. The vein was then easily exposed by blunt dissection. The injections were carefully timed. Oozing was prevented by the use of a small needle and the application of a pledget of cotton after withdrawal of the needle. The animals were at once removed from the board after injection and kept under observation for twenty-four hours. They were most minutely observed during the first hour after injection. Throughout the experiments precautions for sterility were rigidly observed. Sterile pipettes were always used in transferring the gum from the bottles to test tubes and flasks. In short, the experiments were conducted with rigid bacteriologic technic.

Number of Animals Used to Test a Given Dose.—In the course of investigations on anaphylaxis and related phenomena it was observed that there is marked irregularity of susceptibility in guinea pigs. These animals display a considerable variation of resistance to injections of substances in the colloidal state and to serum rendered toxic by admixture with such substances. Animals of a given weight cannot, therefore, be considered as uniform reagents. It is inadvisable, therefore, to draw conclusions from the effect of a single dose on one animal. Two, three, and even more guinea pigs had better be employed on the chance that a

certain percentage of these will be far more susceptible than others. This plan was followed out in all of the experiments described below.

Test of Gum Salt Solution A-p 1.—This solution was prepared November 10th. In appearance the solution showed a pearly-gray opalescence. There was no precipitate, nor could any suspended particles be detected by the unaided eye. The technic used was that just described. The dose given was 1/6 blood volume.

TABLE 1

No.	G. S. sol.	Inj. time in sec.	Wt. g. p. in gms.	Dose in c.c.	Result
1	A p. 1	65	426	5.3	Hyp. excit. shivers.
2	A p. 1	59	495	6.3	Like 1.
3	A p. 1	78	547	7.0	Violent shivering.
4	A p. 1	59	377	4.8	Hyp. excit. urin.
5	A p. 1	70	462	6.3	Nil.

Very slight results followed the injections just summarized in Table I. Hyperexcitability, urination and defecation and shivering are frequently observed as precursors of violent shock of the anaphylactic type. Sometimes these are the sole effects observed when sub-fatal doses are given. On the other hand, such effects are vague, not capable of accurate measurement and in no sense quantitative indicators of a disturbance of this type. From such symptoms as those following the injections just described absolutely no conclusions can be drawn. In subsequent experiments they will be lumped under the designation, "very slight effect," and particular attention will be called to them only when one, such as peripheral irritation, is particularly marked.

In reactions occurring between substances in the colloidal state it is frequently observed that too great concentration of one or both of the reacting substances inhibits the process. Consequently it was thought wise to inject doses lower than 1/6 blood volume as well as those higher than that proportion. In other words, it might be possible to introduce into the circulation such a concentration of gum as to inhibit any reaction that would tend to take place.

Using the same sample of gum, therefore, as that employed in the first experiment, guinea pigs were injected with a wide range of doses, from 1/10 to ½ blood volume. Three animals were employed for each of the above doses in order to avoid the error of interpretation that might arise from one negative result.

The experiment was carried out with the same gum (A-p 1) as that used in Table I. The same methods of calculation of dose and the same general technic obtained throughout the experiment.

The results of this experiment will be found to be summarized in Table II.

A glance at the results recorded in Table II will indicate that very large amounts of gum salt solution may be introduced into the circulations of guinea pigs with no very harmful result. It is worthy of notice,

TABLE II

No.	G. S. sol.	Propor. bld. vol.	Inj. time in sec.	Wt. of g. p.	Dose in c.c.	Result
1			60	405	3.1	V. sl. effect.
2	A p. 1	1/10	60	420	3.2	V. sl. effect.
3			60	370	2.8	V. sl. effect.
4			60	400	3.4	Nil.
5	A p. 1	1/8	58	347	2.8	V. sl. effect.
6			60	450	3.6	V. sl. effect.
7			60	375	3.5	V. sl. effect.
8	A p. 1	1/8	60	450	4.3	Nil.
9			60	405	3.8	Nil.
10			60	355	3.8	P. i. marked.
11	A p. 1	1/7	60	365	4.0	P. i. extreme.
12			60	470	5.0	P. i. ex. degree.
13			58	475	7.2	Ex. lab. resp.
14	A p. 1	1/6	55	425	6.5	Sl. spasms.
15			55	345	5.3	V. sl. effect.
16			65	470	9.0	V. sl. effect.
17	A p. 1	1/4	58	454	8.7	V. sl. effect.
18			85	654	12.0	V. sl. effect.
19			65	400	10.0	V. sl. effect.
20	A p. 1	1/3	68	407	10.3	V. sl. effect.
21			60	423	10.6	V. sl. effect.
22			85	365	14.0	P. i. hyp. excit.
23	A p. 1	1/2	95	360	13.5	V. sl. effect.
24			100	360	13.5	V. sl. effect.

furthermore, that of all the doses given the 1/7 blood volume produced the most noticeable effect. The peripheral irritation noticed in all three of the animals injected with this dose is a quite common preliminary to the disturbance of the anaphylactic type. The effects in the cases of Nos. 10, 11 and 12 were so striking that three more guinea pigs were injected with a similar dose. In two cases out of three some peripheral irritation was observed, although not to so marked a degree as in the case of the first three.

Test of Gum Solution B p. 1.—This solution was much older than that used in the experiments just described. The solution was prepared on September 7, 1918, approximately three months before the day of injection. Although the solution was of a pearly-gray opalescent appearance similar to that of A p. 1, there was a considerable precipitate in the bottom of the bottle. This, upon vigorously shaking the container, went into suspension and remained in this condition for several hours before settling out. Accordingly, the bottle was well shaken before the solution was transferred to test tubes. These tubes were placed in the water bath at 42 degrees for twenty minutes before the beginning of the injections.

In this experiment 1/7, 1/6, 1/4 and 1/3 blood volume was injected. Three pigs were injected with the first named proportion, two each with

TABLE III

No.	G. S. sol.	Propor. bld. vol.	Inj. time in sec.	Wt. of g. p.	Dose in c.c.	Result
1			60	350	3.8	V. sl.
2	B p. 1	½	60	430	4.7	Ur. p. i. spasms.
3			60	660	7.1	Ur. p. i. edema collapse.
4	B p. 1	⅓	60	400	5.1	P. i. marked.
5			60	520	6.6	Hyp. excit. spasms.
6	B p. 1	¼	60	502	9.6	V. sl.
7			70	369	7.0	V. sl.
8	B p. 1	⅛	72	440	10.3	P. i.
9			85	500	12.3	V. sl.

TABLE IV

TEST OF SERIES OF GUM SAMPLES OF VARYING AGE

No.	Appearance of sample	Age of prep.	Propor. bld. vol.	Inj. time in sec.	Wt. of g. p.	Dose in c.c.	Result
	A p. 5						
1	Light		½	60	452	4.9	V. sl. effect.
2	brown,		½	60	420	4.6	V. sl. effect.
3	opalesc.	98	⅓	65	485	7.4	V. sl. effect.
4	no ppt.	days	¼	58	485	7.4	V. sl. effect.
5			⅛	80	575	14.6	V. sl. effect.
6			¼	60	465	9.0	V. sl. effect.
	B p. 5						
7	Gray		½	55	437	4.8	Ext. p. i. spasms.
8	opalesc.		½	55	487	5.2	V. sl. effect.
9	no	93	⅓	60	452	6.9	V. sl. effect.
10	ppt.	days	¼	60	452	6.9	V. sl. effect.
11			⅛	120	440	11.3	V. sl. effect.
12			⅛	78	400	10.0	V. sl. effect.
	C p. 5						
13	Gray		½	55	505	5.5	V. sl. effect.
14	opalesc.		½	60	555	6.0	V. sl. effect.
15	no	91	⅓	63	525	8.0	V. sl. effect.
16	ppt.	days	¼	60	500	7.4	V. sl. effect.
17			⅛	65	345	8.8	V. sl. effect.
18			⅛	75	400	10.0	V. sl. effect.
	D p. 5						
19	Light		½	60	470	4.6	V. sl. effect.
20	brown		½	60	495	5.4	V. sl. effect.
21	opalesc.	89	⅓	60	460	7.3	V. sl. effect.
22	sl.	days	¼	55	430	6.6	V. sl. effect.
23	ppt.		⅛	85	380	9.6	Dead 20′ *.
24			⅛	96	400	10.0	V. sl. effect.
	E p. 5						
25	Gray		½	60	505	5.4	Nil or v. sl. effect.
26	opalesc.		½	60	455	5.0	Nil or v. sl. effect.
27	mod.	82	⅓	60	460	7.0	Nil or v. sl. effect.
28	ppt.	days	¼	55	475	7.1	Nil or v. sl. effect.
29			⅛	85	405	10.1	Nil or v. sl. effect.
30			⅛	96	350	9.0	Nil or v. sl. effect.

* Autopsy showed death due to vascular rupture and internal hemorrhage.

the other three. The results of the experiment are recorded in Table III.

The effects produced by this sample of gum salt were considerably greater than those following the injection of A p. 1. It is again true that the most marked results are produced by amounts around the dose of 1/7 blood volume. It is to be especially noted that no really severe anaphylactiform effect has been produced. No dyspnœa, severe respiratory spasms have occurred. It has been the impression of some observers that the older samples of gum salt were the ones causing trouble. In this case, however, we are dealing with a preparation three times as old as that used in experiment I, yet there is no clean-cut difference in toxicity between the two samples.

TABLE V

No.	Appearance of sample	Age of prep.	Propor. bld. vol.	Inj. time in sec.	Wt. of g. p.	Dose in c.c.	Result
	F p. 5						
1	Dark		1/7	57	625	6.7	P. i. urinat.
2	brown		1/7	60	600	6.5	spasm lab.resp.collapse
3	marked	80	1/6	75	525	7.2	Hyperexcit.
4	ppt.	days	1/6	65	570	8.7	Ext. p. i. collapse sp.
5			1/5	115	370	9.3	V. sl. effect.
6			1/5	120	360	9.0	V. sl. effect.
	G p. 5						
7	Gray		1/7	55	775	8.4	All nil.
8	opalesc.		1/7	60	500	5.6	All nil.
9	no	67	1/6	60	395	6.0	All nil.
10	ppt.	days	1/6	60	395	6.0	All nil.
11			1/5	85	310	7.2	All nil.
12			1/5	120	470	12.0	All nil.
	H p. 5						
13	Gray		1/7	55	650	7.1	Resp. sp. ur. shivers.
14	opalesc.		1/6	60	700	7.5	Nil.
15	no	37	1/6	66	490	7.5	Dead 24 mon.*
16	ppt.	days	1/6	67	550	8.4	V. sl. effect.
17			1/5	108	430	11.0	V. sl. effect.
18			1/5	110	460	11.6	Hyperexcit.
	I p. 5						
19	Gray		1/7	58	560	6.1	All nil or v. sl. effect.
20	opalesc.		1/7	63	580	6.1	Nil or v. sl. effect.
21	mod.	36	1/6	70	700	10.3	Nil or v. sl. effect.
22	ppt.	days	1/6	63	590	9.0	Nil or v. sl. effect.
23			1/5	110	460	12.0	Nil or v. sl. effect.
24			1/5	110	440	10.3	Nil or v. sl. effect.
	J p. 5						
25	Gray		1/7	60	700	7.5	V. sl. effect.
26	opalesc.		1/7	55	520	5.7	V. sl. effect.
27	v. sl.	35	1/6	62	550	8.4	V. sl. effect.
28	ppt.	days	1/6	60	575	8.8	V. sl. effect.
29			1/5	95	455	11.6	V. sl. effect.
30			1/5	90	400	10.0	V. sl. effect.
	K p. 5						
31	Brown		1/7	60	530	5.8	V. sl. effect.
32	v. sl.	34	1/7	55	500	5.4	Jerky resp.
33	ppt.	days	1/6	60	470	7.2	Remainder.
34			1/6	58	430	6.6	Nil or v. sl. effect.
35			1/5	120	430	11.0	Nil or v. sl. effect.
36			1/5	90	430	11.0	Nil or v. sl. effect.

* Autopsy showed vascular rupture and internal hemorrhage.

It was decided that no conclusion could be drawn from the testing of two preparations only. The next step was, then, to study systematically a long series of preparations of different ages with a view toward discovering if any were toxic or if all were as comparatively innocuous as the first two investigated.

The tests of the remainder of the samples in the series are summarized in Table V.

Out of a series of 11 preparations in which in all 66 animals were injected, very few if any perceptibly toxic effects were obtained. The most notable of these occurred in the case of Fp.5, the results of which are shown in Table V, Nos. 1–6. Several of the animals injected with this preparation showed marked peripheral irritation and in two cases quite severe symptoms, including collapse, made their appearance. It is to be noted that this sample had a very bad physical appearance. The color was dark brown and a fairly heavy precipitate was present in the bottom of the flask. This, of course, had been shaken into a uniform suspension before injection. In the total series two deaths resulted. At the time these appeared atypical, autopsy showed them to be due to vascular rupture at some point in the peritoneal cavity, most probably the liver. Summing up it may be said that no marked anaphylactiform effect followed the injection of any of the samples in this extensive experiment.

Test of Gum Salt Solutions Subjected to Cold.—The reports of the deleterious effects of gum injection had only begun to be heard in the fall months during the Argonne-Meuse drive. It is well known that the evacuation in this drive was much slower than in the Chateau-Thierry push and the wounded were in much poorer condition. But the condition of the recipients, while probably the most important factor in the alleged bad effects of the gum injections, cannot be taken into account in this work. It is possible, however, that the cold might have had some effect on the gum solution itself. It was thought that the physical state of the gum might have undergone some alteration as the result of exposure to the cold. Continued exposure to lower temperatures may have induced some phenomenon corresponding to the gelation of certain hydrophile colloids, of which agar is an example. This change might not result in a visible setting as in the latter case, but on the other hand, some alteration in extent of surface or in configuration of particles might change the gum from a harmless to a dangerous substance. Tentatives at experimental approach to this question were made in the following way.

Gum solutions Bp. 1 and Gp. 5 were used in the first experiment. Table II may be consulted in reference to Bp. 1, Table V in reference to the activity of Gp. 5. The former had shown some slight evidence of harmful effect. The latter had proved to be practically innocuous. The solutions were taken from the identical samples employed in the experiment just mentioned.

A freezing mixture, ice-salt, was prepared having a temperature of −12 degrees. Seventy-five c.c. each of Bp. 1 and Bp. 5 were placed in two 100 c.c. Erlenmeyer flasks and the latter surrounded by the freezing mixture for a period of four hours. Examination of the solutions with dark field showed no perceptible change after this exposure to the cold. Both solutions immediately after this treatment were brought to 42 degrees and injected with the technic described above. The results are recorded in Table VI.

TABLE VI

No.	Sol. inj.	Bld. vol. propor.	Inj. time in secs.	Wt. of g. p.	C.c. inj.	Result
1	B p. 1	1/7	57	505	5.5	Shiver-hyperexcit.
2	B p. 1	1/7	60	485	5.3	Hyperexcit.
3	B p. 1	1/5	110	540	6.8	V. sl. effect.
4	B p. 1	1/5	60	460	5.6	P. i. hyperexcit.
5	G p. 5	1/5	55	420	5.3	Nil.
6	G p. 5	1/5	60	430	5.3	Nil.

Several other experiments of a similar nature were attempted with different preparations exposed to different temperatures. In no case was any increase in effect observed. In one series solution Fp. 10 was injected without preliminary warming, after being subjected to 0 degrees temperature for four hours. No marked effect was observed.

Test of Sterility of Samples.—Some of the gum preparations exhibited upon inspection a cloudiness reminiscent of fluids contaminated with bacteria. It was, therefore, considered desirable to test the samples for possible bacterial contamination. These tests were carried out in every case before the bottles submitted to experiment were opened for removal of a portion of the gum for toxicity test. Direct microscopical preparations were made, following which tubes of plain infusion broth were seeded with 1 c.c. of each sample and incubated for four days. Out of a series of 35 samples of gum salt, each of which had been made on a different date, three were found to be contaminated. This was shown both by direct examination and by cultural test. Check cultures of the contaminated samples were at once made to avoid the error of accidental contamination of medium.

Preparations K-p. 10 and O-p. 10 were heavily contaminated with a bacillus of the subtilis group. C-p. 12 was found to contain both staphylococcus aureus and an unidentified slightly motile bacillus. It was thought possible that while the organisms might not be particularly harmful *per se*, complexes of gum-bacteria might be formed which when injected could cause a disruption in the equilibrium of the blood colloids or produce changes at the surfaces of body cells.

The effect of these contaminated preparations on guinea pigs was consequently tried. One of these, C-p. 12, presented a peculiar appearance to the unaided eye. The color of the solution was pearly gray, a consid-

erable precipitate had accumulated at the bottom of the bottle, while close inspection revealed a large number of evenly suspended, minute, flocculent particles which did not precipitate. Dark field examination indicated these to be clumps of bacteria, predominatingly staphylococcus, in a sort of matrix of amorphous particles.

This sample, C-p. 12, had been brought down from the advanced medical supply dump at Souilly. It bore the date mark of preparation of September 9, 1918, and had evidently been made at the central laboratory. It was subjected to intravenous injection into guinea pigs as follows. The results of the injection are summarized in Table VII.

TABLE VII

No.	Propor. bld. vol.	Inj. time in secs.	Wt. of g. p.	Dose in c.c.	Result
1	⅛	60	450	4.2	Hyperexcit. sev. depress.
2		55	505	5.5	V. sl.
3	⅛	60	450	5.0	Dead 4′ typical shock.*
4		60	445	5.0	Dead 3h. 45′ atypical.†
5		60	440	4.7	P. i.
6	⅛	60	455	5.3	Urinat. lab. resp.
7		65	450	5.8	Ext. hyper. excit. jerk. resp.
8		60	420	6.4	Ext. hyperexcit. spasm sick.
9	⅛	60	410	6.2	Dyspnœa severe effect.
10		55	400	6.0	V. rapid shallow resp.
11	⅛	65	480	9.1	P. i. spasm collapse v. severe.
12	⅛	97	470	12.0	Edema resp. spasms.

This sample revealed by far the most severe effect of any tested. The shock produced in No. 3 was perfectly typical of anaphylaxis. The autopsy also showed the typical picture. Repeated attempts were made to duplicate this result without success and it was finally concluded that an extraordinarily susceptible animal was being dealt with, this susceptibility being natural or, what is more likely, caused by the pneumonia which was undoubtedly present. On the other hand, a number of the animals injected displayed severe effects. These have been caused by the extensive amount of bacterial protein injected.

Attempts were made to obtain similar effects by seeding sterile harmless gum solution with the microbes isolated from the last studied somewhat toxic sample. The experiment was carried out as follows:

Gum D-p. 5 was chosen for the experiment. In the experiment summarized in Table IV this preparation had shown itself to be entirely harmless for the guinea pig in the doses employed.

A. 80 c.c. of gum salt D-p. 5 were placed in a 100 c.c. Erlenmeyer flask and seeded with 12 mm. loop of St. aureus isolated from C-p. 12.

* Autopsy showed extreme emphysema, persistence of heart beat, delayed coagulation of blood. Also extensive pneumonic involvement of left lung.

† Autopsy showed death from vascular rupture—internal hemorrhage peritoneum.

B. Like amount of the same gum sample placed in flask and seeded with 1 c.c. of a broth culture containing the staphylococcus and the bacillus isolated from C-p. 12.

C. 80 c.c. of sterile gum salt, D-p. 12 placed in Erlenmeyer flask as control.

Flasks A, B and C were now incubated and tested at the end of 48 and 96 hours. At the end of 48 hours there was a heavy growth of staphylococcus in both A and B, but no bacillus in B. The control tube, C, remained sterile. At the end of 96 hours the growth of staphylococcus in both flasks was still heavier, and a few bacilli were visible in B. The organisms remained partly in suspension, partly precipitated. It is worthy of note that the suspended floccules present in C-p. 12 were not present in either A or B. The results of the experiment are summarized in Table VIII.

TABLE VIII

No.	Sol. inj.	Hrs. incub.	Propor. bld. vol.	Time inj.	Wt. of g. p.	c.c. inj.	Result
1	A	48	1/5	60	410	4.4	P. i.
2	A	48	1/5	60	440	4.7	Spasms severe.
3	A	48	1/5	65	430	6.6	Sev. resp. effect.
4	B	48	1/5	70	470	5.1	V. sl. effect.
5	B	48	1/5	60	490	5.2	Resp. spasm.
6	A	96	1/5	55	420	4.5	Hyperexcit.
7	A	96	1/5	60	490	5.2	V. sl. effect.
8	A	96	1/5	75	590	9.2	Jerky resp.
9	A	96	1/5	80	485	9.7	V. sl. effect.
10	B	96	1/5	50	500	5.4	Resp. spasm.
11	B	96	1/5	50	430	5.2	Nil.

While some of the guinea pigs injected showed some effect the result was not nearly so severe as in the case of C-p. 12. It is possible that the agglomerations observed in that sample only occur after the bacteria have been present over a considerable period of time. There was no opportunity to put this conjecture to experimental test.

Gum salt solution B-p. 12 brought down from the medical supply dump of the Justice Group, Second Army, also exhibited the peculiar flocculent suspension observed in the case of C-p. 12. It was not contaminated, nor was there any precipitate in the bottom of the bottle. The preparation had been made and sterilized at the front. On account of the close resemblance of the floccules to those of C-p. 12, it was most carefully tested for toxicity. A series of guinea pigs were injected intravenously as before, but aside from the minor effects observed after the injection of any solution of gum, no serious effects followed.

The two other contaminated samples, K-p. 10, and O-p. 1, were also injected into a series of guinea pigs. The result of the tests is summarized in Table IX.

In two cases out of the eight animals injected severe effects were observed, *i.e.*, in Nos. 2 and 5. The results were not as alarming as in the case of C-p. 12, but it is still worthy of note that some noticeable effect is observed

TABLE IX

No.	Sol. inj.	Propor. bld. vol.	Inj. time	Wt. of g. p.	c.c. inj.	Result
1	K p. 10	1/7	60	460	5.0	P. i.
2	K p. 10	1/7	60	400	4.2	Hyp. excit. resp. lab. depress
3	K p. 10	1/8	60	580	8.8	Int. hypexcit. p. i. spasms.
4	K p. 10	1/8	60	570	8.7	Hyp. excit.
5	O p. 10	1/7	60	700	7.5	Spasms p. i. collapse (severe)
6	O p. 10	1/7	60	570	6.1	V. sl. effect.
7	O p. 10	1/8	60	400	6.0	Hyp. excit.
8	O p. 10	1/8	60	350	5.4	Hyp. excit.

in the case of all three of the contaminated samples, while the great majority of sterile preparations tested exhibit little or no result.

Effect of Gum Salt on Rat and Guinea Pig Serum.—It is well known that certain hydrophile colloids, such as agar (Bordet), starch and inulin (Nathan), and pectin (Mutermilch and Kopaczewski) are capable of rendering normal guinea pig serum extremely toxic for homologous animals. Novy and De Kruif have shown that this reaction occurs with greater intensity in the case of rat serum. Thus a 200 gm. guinea pig will tolerate with ease a dose of 4 c.c. or more of normal rat serum. On the other hand, when the serum is first incubated for a short time with a minute quantity of agar, it becomes extremely toxic, killing guinea pigs of the weight just mentioned in dose of from 0.1 to 0.5 c.c. The symptoms and picture at autopsy are not to be differentiated from those of true anaphylaxis.

It has been demonstrated that this reaction, so easily produced *in vitro*, can be produced *in vivo* by the injection of agar which has been brought into a suitable physical state. In both cases some interaction of the foreign colloid with substances in the colloidal state in the serum is responsible for the effects obtained.

Since practically all the preparations of gum examined had proved themselves so harmless for the guinea pig, it was thought desirable to test the effect of this substance on rat serum. The latter is a most delicate indicator of the "disturbing" power of colloids, and it would be interesting if the harmlessness of the gum *in vivo* were borne out by its inability to render toxic the serum of the rat. On the other hand, if it showed itself to possess such power, further careful study would have to be carried out.

The first experiment was conducted as follows: Gum salt solution J-p. 5 had little or no effect when injected into guinea pigs (see Table V, Nos. 25–30). This solution was used as gum sample in this experiment. A number of white rats were bled from the heart, the blood defibrinated by rod, pooled, centrifugated and the serum pipetted off.

A. 1 c.c. of sterile 0.85 per cent. NaCl solution added to 4 c.c. of normal rat serum, placed in water bath at 40, and tested for toxicity after incubation for 30 minutes and 60 minutes.

TABLE X

No.	Inc. time 40 degrees	Sol. inj.	Wt. of g. p.	c.c. inj.	Result
1	30	A	275	2.5	Nil.
2	30	B	275	2.5	Nil.
3	60	A	270	2.5	Nil.
4	60	B	250	2.27	Nil.

B. 1 c.c. G. S. J-p. 5 added to 4 c.c. normal rat serum, placed at 40 in bath, tested as in case of *A.* intravenous injection.

There was no perceptible difference in the effect of *A* and *B* in this experiment. The gum had no more effect than the normal salt solution on the toxicity of the rat serum.

It was thought desirable to test the action of other gums, particularly those which had shown some harmful effect. Further, the negative effect of the gum (if the effect should be in every case negative) would be more strikingly shown by the addition of a positive control. Consequently a 0.5 per cent. solution of agar in 0.85 per cent. NaCl solution was prepared. The agar, 0.5 gm., was cut into small pieces and placed in 100 c.c. of sterile 0.85 per cent. NaCl solution. The mixture was autoclaved for 30 minutes at 120 degrees. When cool, this solution sets to a gel which can be easily shaken up to a semifluid, lumpy mass. The solution, because of its low concentration in agar, will remain liquid at 38–40 degrees for several hours.

TABLE XI

No.	Mixt. inj.	Inj. time	Dose ser. per gm. of g. pig.	Wt. of g. p.	c. c. inj.	Result
1	A	60	.008	250	2.25	Nil.
2	A	60	.012	220	3.75	Nil.
3	B	60	.004	250	1.0	Dead 3′ typical.
4	B	60	.003	250	0.75	V. severe shock.
5	B	60	.003	200	0.6	Dead 3′30″ typical.
6	B	60	.002	200	0.5	Dead 3′ typical.
7	B	60	.001	200	0.35	Dead 4′10″ typical.

Gum solution B-p. 1 was used in the experiment. For the effect of this solution on guinea pigs see Table III. The serum obtained in the preceding experiment was divided into two parts and treated as follows:

A. 10 c.c. normal rat serum added to 2.5 c.c. G.s. B-p. 1, placed in cracked ice for two hours, then incubated for 60 minutes at 40 degrees, centrifugated and injected.

B. 7 c.c. normal rat serum added to 1.75 c.c. of agar hydrosol, mixed, placed in cracked ice for two hours, incubated for 60 minutes at 40 degrees, centrifugated and injected.

Results summarized in Table XI.

The experiment just described and summarized in Table XI illustrates strikingly the wide difference of effect of gum and agar on rat

serum. Agar acting for one hour on rat serum brought it to a toxicity of .0012 per g. of guinea pig. On the other hand, .012 per g. (ten times as much) of the gum-treated serum had no effect.

It is possible that as in the case of so many reactions between substances in the colloidal state an optimum quantitative balance between the reacting elements had not been obtained. To test this the following experiment was devised. Various quantities of gum salt solution were added to constant amounts of normal rat serum. As a positive control a minute amount of agar was added to another tube of serum.

A. 2.0 c.c. normal rat serum added to 1 c.c. G.S. B-p. 1.
B. 2.0 c.c. normal rat serum added to 0.28 c.c. G.S. B-p. 1.
C. 2.0 c.c. normal rat serum added to 0.20 c.c. G.S. B-p. 1.
D. 2.0 c.c. normal rat serum added to 0.10 c.c. G.S. B-p. 1.
E. 3.5 c.c. normal rat serum added to 0.07 c.c. 0.5 per cent. agar.

All of the above mixtures were incubated at 40 degrees for 60 minutes, and following that injected intravenously into guinea pigs. The results of the experiment are summarized in Table XII.

TABLE XII

No.	Mixture	Propor. G. s. or agar to serum	Inj. time of mixtures	Wt. of g. p.	c. c. inj.	Result
1	A	1–2		300	3.0	V. sl.
2	B	1–7	–60′	420	2.28	Rapid resp.
3	C	1–10		420	2.20	Nil.
4	D	1–20		380	2.10	Nil.
5	E	1–50		400	1.0	Sev. shock.
6	E	1–50	–60′	300	1.0	Near kill.
7	E	1–50		380	0.8	Sev. shock.

Tables XI and XII indicate that minute amounts of agar can cause intense toxic increase in rat serum, while the gum salt solutions tested in various concentrations produce no appreciable effect on the serum from the same pool.

Similar experiments, again using agar as a positive control, were made with guinea pig serum (homologous serum). Various gum samples were used, *i.e.*, B-p. 12, J-p. 5, and even C-p. 12. The latter might have been expected to have caused a toxic change because of the bacteria present. Such, however, was not the case. Amounts of guinea pig serum up to 5.3, after incubation with gum, were harmless for homologous animals.

Effects of Intravenous Injections of Minute Amounts of Agar on Guinea Pigs.—It might be of interest to demonstrate the effect of very small amounts of agar intravenously injected into guinea pigs and to compare these effects with the slight ones in general produced by gum injections.

Nathan has shown that the power of inulin to render guinea pig serum toxic depends largely on the physical state of the inulin. Similarly the writer, together with Novy, succeeded in demonstrating that agar,

brought into a suitable physical state, can produce the same effect *in vivo* that it produces *in vitro* when mixed with guinea pig serum.

The general method of preparing agar for such injection is as follows: 0.5 per cent. agar-salt solution is boiled, cooled to 40 degrees, and while still liquid is diluted with 6 to 9 parts of sterile NaCl solution. This dilute agar is then subjected to 0 degrees temperature for two hours. It is too dilute to set into a gel, but close inspection reveals that the solution has changed from a uniform gray opalescence to one containing evenly suspended, minute floccules of gel. This suspension, when warmed and injected intravenously, produces severe effects in guinea pigs and in appropriate dose frequently kills them with effects typical of those of anaphylaxis.

The following experiment will illustrate this:

A. 0.5 per cent. agar boiled 10 minutes then cooled to 40 degrees. Five c.c. of above added to 45 c.c. of 0.85 per cent. NaCl solution and placed at 5 degrees for two hours.

B. Same 40 degree agar solution added (5 c.c.) to 35 c.c. of 0.85 per cent. NaCl solution and subjected to cold as in A.

Both warmed to 40 degrees and injected into guinea pigs. The results of this experiment are summarized in Table XIII.

TABLE XIII

No.	Sol. inj.	Inj. time	Wt. of g. p.	Mg. of agar	c. c. inj.	Result
1	A	100	440	5.0	10.0	Dead 20′ typical shock.
2	A	115	470	5.0	10.0	Sev. dysp. convulsions.
3	A	45	420	3.25	6.5	Hyp. excit. ext. depress.
4	A	90	490	6.0	12.0	Resp. spasms dyspnœa.
5	B	70	470	6.25	10.0	V. rapid heavy rasp. v. sick.
6	B	115	610	7.5	12.0	Dead 23′ typical shock.

It will be observed that such small amounts as 5 mg. of agar can cause fatal result when intravenously injected into guinea pigs. It may be remarked here that far larger amounts can be injected with little effect when the undiluted, unchilled hydrosol is used.

It appears that the attainment of an appropriate surface development of the agar particles plays an important rôle in the production of a toxic effect.

Attempt at Production of Agglutination of Guinea Pig and Red Cells with Gum.—At the request of Colonel Cannon such experiments were conducted with various gum preparations both on oxalated guinea pig blood and on the washed red cells of the same species. With high concentrations of gum (1–1 gum-blood) and in certain cases in concentrations of 1–2 and 1–3, some hemagglutination took place. But in general the reaction was feeble and rather easily reversible. The clumps of red cells were not firmly adherent, repeated shaking bringing the cells back into

a suspension from which no clumping but only uniform gradual settling occurred.

Summary and Conclusions.—A large number of preparations of the gum-salt solution made at the central laboratory and used in resuscitation work at the front have been subjected to toxicity tests in guinea pigs. The aim of the experiments was to discover whether these solutions might possess the " equilibrium disturbing " effect that certain substances in the colloidal state show when injected into the circulation.

With one exception no effects of an anaphylactiform nature were observed. Slight symptoms of various kinds which followed the injection of massive doses of certain samples were of so little importance that they could be disregarded.

The exception just mentioned was that of a sample contaminated with staphylococcus aureus and an unidentified bacillus. Severe effects followed the injection of this preparation. One guinea pig succumbed with typical anaphylactic symptoms. It is to be noted that this animal was not a normal one but was shown at autopsy to be pneumonic.

Normal harmless gums seeded with the organisms isolated from the preparation just described showed some increase in toxicity, which was not, however, as marked as that of the original sample.

Out of 35 samples tested for sterility, 3 were found to be contaminated. This is a serious indictment of methods of control of sterility used by those making the gum solutions.

Attempts to produce a toxic state in gum solutions by subjecting them to cold failed.

Attempts to make normal rat and guinea pig sera " anaphylatoxic " with various samples of gum did not succeed. This furnishes important confirmatory evidence of the harmlessness, as far as the anaphylactic effect is concerned, of the gum solutions.

THE TREATMENT OF BURNS

AN EXPERIENCE IN THIRTY-ONE CASES DUE TO FOREST FIRES

By Archibald L. McDonald, M.D.
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The forest fires of October 12, 1918, brought to the hospitals of Duluth and neighboring towns many cases of severe burns. From the morning of October 13, it was my good fortune to have charge of the burned and refugee patients during their treatment at St. Luke's Hospital. We have records of 31 cases of extensive burns which were cared for largely with paraffine treatment. It seems desirable to put our experience and conclusions on record. A number of physicians, especially Drs. F. M. Turnbull, H. Klien, A. H. Schwartz, D. L. Tilderquist and Homer Collins, were of most material assistance in the preliminary care. The regular hospital nursing staff, together with several Red Cross nurse's aids, were tireless in helping with the dressings.

The chart explains the extent of the burns, duration of treatment, complications and results. In addition to the shock resulting from the burns, all of the patients had suffered from severe exposure. Chilling together with irritation by smoke caused a most persistent bronchitis in nearly all cases.

Three types of cases terminated fatally: 1. Those where burns involved over one-half of the body, these died within six hours. Cases 16–30.

2. Those suffering from the effects of severe pulmonary congestion. Cases 1, 12 and 13. Case 1 suffered comparatively little from external burns, but had inhaled flame and smoke. He presented a most peculiar condition of excitement and delirium on admission. After receiving ¼ grain morphine, exhaustion and coma with noisy stertorous breathing followed. In spite of vigorous stimulation—coffee per rectum, camphorated oil and pituitrin hypodermically—the man died in a few hours. Cases 12–13 presented extensive burns, but the most striking feature was massive pulmonary congestion with stertorous breathing and the immediate cause of death was œdema of the lungs. Though both these women lived for several days, no treatment was of any avail.

3. "Late toxæmia" and exhaustion, a condition we could neither explain nor apparently influence, caused death in several cases (2, 15, 18, 26). Most of them showed temporary improvement and there was some healing about the burns. The general condition of these patients, however, was never satisfactory and there was little definite reaction from the primary shock and depression.

Routine urine examinations were made in all the cases but aside from an occasional trace of albumen there seemed to be but little urinary dis-

turbance. After a varying period the patient became toxic and weak, sloughs extended and there was no response to the usual forms of stimulation. Blood transfusion was not tried but might have been of value.

A number of other patients were in a more or less precarious condition for the first week or so, after which improvement both of general condition and of the burns was progressive. Tonics, especially iron and strychnine, were used freely.

In the first aid treatment we had two considerations.

1. *Dressings.*—Nearly all of our cases had been dressed with Carron oil on admission. This did not give comfort, was dirty and disagreeable, and at the suggestion of Doctor Schwartz we dressed the later cases with gauze saturated with 10 per cent. sodium bicarbonate solution. This gave immediate relief, and, if kept moistened at frequent intervals, was much more comfortable than anything else. In our experience it is the dressing of choice for first aid, since it is always available, is easily applied, is not mussy or dirty and gives prompt relief. We believe that the complicated technic of paraffine is best reserved till the initial shock and depression is overcome, if this be at all marked.

2. *Relief of Pain; Treatment of Shock.*—Pain is overcome to a great extent by a suitable dressing. In extensive cases removal of blisters and the rather complicated dressings are not advisable, for reasons already mentioned. Ten per cent. sodium bicarbonate solution on gauze is easily applied and gives instant relief. We ordered the dressings moistened every hour or two for the first thirty-six hours.

Morphine is usually necessary and should be given in efficient amounts. The effect must be closely watched and stimulation may be necessary on account of severe depression. We used heat externally, elevation of the feet, hot coffee per rectum, camphorated oil hypodermically, and strychnine, in some cases. Hot drinks including tea, chocolate or water were given at hourly intervals.

A few patients were extremely restless and unable to sleep in spite of rather heavy doses of morphine. These we found responded to chloral hydrate by mouth or rectum. More than a half of the patients were in a precarious condition for a number of days, and, as already noted, several failed to react and died.

The after care is long and tedious. Within forty-eight hours we were able to go over all except the obviously hopeless cases, remove blisters and substitute paraffine. We used the metal atomizer, but had great difficulty with rubber bulbs. The use of a portable air tank simplified the technic. When this was pumped up to from 10 to 20 pounds pressure we were able to keep a constant spray of paraffine and dress the large burns rapidly and painlessly. " Dichloramine T " in oil was sprayed on the surface before the paraffine but it was difficult to see any benefit and the patients complained greatly of the pain. During the period of sloughing, wet dressings of potassium permanganate were used freely

No.	Sex	Age	Extent of Burns	Complications	Treatment	Date of discharge or death	Result
1	Male	50	Hands, face	Pulmonary congestion, shock, delirium, coma	Morphine and coffee stimulants	Oct. 13, 1918	Died
2	Male	20	Hands, face and head	Sloughing, gangrene, hemorrhage, pulmonary congestion, depression	Paraffine, wet permanganate	Oct. 29, 1918	Died of toxæmia
3	Male	60	Face, head, neck, many areas of back, both hands, legs	Gangrene, sloughing of fingers and thumbs	Paraffine and permanganate	Mar. 15, 1919	Loss of hands
4	Male	21	Both hands	None	Paraffine	Oct. 20, 1918	Good
5	Male	25	Face and both hands	None	Paraffine	Oct. 29, 1918	Good
6	Male	72	Hands, large areas of back and thigh	None	Paraffine, skin graft, adhesive	Dec. 10, 1918	Good
7	Male	45	Face, both hands	Eye and ear	Paraffine	Dec. 13, 1918	Good
8	Male	40	Face, both hands and leg	None	Paraffine	Nov. 25, 1918	Good
9	Male	50	Both hands, large area on back and side	Influenza	Paraffine and adhesive	Dec. 15, 1918	Good
10	Male	62	Hands, thigh and leg	Varicose veins on leg	Paraffine and adhesive	Dec. 1, 1918	Good
11	Male	45	Head, face, both hands, legs to knee and thighs	Shock	Paraffine	Dec. 11, 1918	Good
12	Female	45	Both hands, limbs, face and neck	Pulmonary congestion, shock and depression	Morphine stimulant	Oct. 14, 1918	Died, pulmonary œdema and shock
13	Female	19	Face, head, chest, hands, arms and feet	Pulmonary congestion, shock and depression	Morphine stimulant	Oct. 16, 1918	Died, œdema of lungs and shock
14	Female	28	Face, hands and legs	Pulmonary congestion, bronchitis	Paraffine	Nov. 15, 1918	Good
15	Female	44	Arms and entire body	Temporary improvement, later hemorrhage, depression and toxæmia	Paraffine and stimulation	Oct. 23, 1918	Died, toxæmia
16	Female	35	Deep burns on body, arms and face	No reaction	Morphine	Oct. 13, 1918	Died
17	Female	38	Deep burns on thigh, back and arm	Influenza three weeks, no progress, sloughing	Paraffine, iodoform, adhesive	Feb. 14, 1919	Good
18	Female	38	Right hand, arm, both legs, abdomen	Deep sloughs, late depression and toxæmia	Paraffine, permanganate	Nov. 11, 1918	Died, toxæmia
19	Female	51	Both hands, feet and ankles	Bronchitis	Paraffine	Nov. 23, 1918	Good
20	Male	10	Head, face, hands and legs	None	Paraffine not consistent also ungentine	Dec. 1, 1918	Fair; scars

21	Female	9	Legs and thighs	Temporary contraction of knees later overcome	Paraffine	Dec. 15, 1918	Good
22	Female	12	Large area of thigh and leg	None	Paraffine	Nov. 8, 1918	Good
23	Female	5	Deep burn on forehead, both legs and thigh	Depression, influenza	Paraffine	Dec. 5, 1918	Died
24	Male	1	Hands and legs	None	Paraffine	Oct. 28, 1918	Good
25	Female	48	Legs and hand	Influenza	Paraffine	Dec. 15, 1918	Good
26	Female	10	Deep burn on side and back	Hemorrhage, poor condition, toxæmia	Paraffine	Dec. 3, 1918	Died
27	Female	12	Legs, feet and neck	None	Paraffine	Dec. 1, 1918	Good
28	Female	8	Legs, feet and back	None	Paraffine	Dec. 10, 1918	Good
29	Female	5	Feet and legs	None	Paraffine	Dec. 15, 1918	Good
30	Female	4	Body and legs	Congestion and shock	Morphine, stimulants	Oct. 13, 1918	Died
31	Female	8	Shoulder and neck	None	Paraffine	Dec. 15, 1918	Good

and kept hot and moist. The surfaces quickly became clean, the sloughs separated rapidly, and new epithelium formed at the edges.

As soon as possible paraffine was substituted again. In a few instances where it was difficult to use wet dressings, the surfaces were dusted with iodoform and boracic acid powder, which seemed much preferable to the Dichloramine T.

Daily dressings were necessary in all cases, since there were always sloughs to remove or purulent secretions collected under the paraffine. We used the commercial paraffine melted in a water bath and sprayed in the apparatus as already described. Considerable care is necessary to get a layer of paraffine the proper thickness, since if too thick it falls off and if too thin is difficult to remove. Various mixtures of paraffine with wax or special antiseptics are discussed in some detail by Sherman.[1] Since the paraffine coating comes in contact with the surface granulations only, antiseptics incorporated in the dressing can have little or no influence and are unnecessary. Special mixtures of paraffine and wax may present some advantages in adhering to the surface but our experience with commerial paraffine of comparatively low melting point was entirely satisfactory. It should be applied by means of an atomizer with from 10 to 20 pounds of pressure from an air tank. This method is simple, rapid and practically painless, which can not be said of the application with a brush. Our results were best where the paraffine was not covered by dressings. This was evident in the burns on the backs of hands or on the legs where the bedding could be held away by a cradle. In these cases the healing was rapid, there were no exuberant granulations, and the resulting skin soon became firm and elastic. Even where there had been extensive sloughing, scarring was negligible and there were no serious contractions of cicatricial tissue. Where the paraffine had to be covered by dressings, it was preferable to any ointment on gauze. Various preparations, such as unguentine or boracic acid ointment, were tried in a few instances or in certain areas, but healing was never as satisfactory as with paraffine or adhesive strapping. There were more exuberant granulations and even where the ointment was thickly applied the surfaces were sticky and the gauze seemed to interfere with epithelial growth. We came to the conclusion that any paste or salve applied on gauze was objectionable.

Adhesive strapping over the raw surface was used at first for certain burns on the back, shoulders, or arms, where the paraffine was not suitable. Healing was fully as satisfactory as with the paraffine and much more so than when an ointment was used with gauze. Strips of Z.O. adhesive about one-quarter inch wide were used to cover the area, leaving narrow openings between, then a few layers of gauze to absorb secretions are held with adhesive or a bandage. The whole dressing is easily removed every second or third day, there are no exuberant granula-

[1] Surg., Gyn. and Ob., vol. xxvi, No. 4.

tions, and epithelial growth is rapid. Later the method was used in areas of considerable size, 6 by 3 inches in one case, with great satisfaction. This method of dressing raw or granulating surfaces has been described many times and is worthy of more extensive use. I have since used it exclusively on small burns and have secured prompt healing. The dressing is comfortable, not bulky, and easily changed, new epithelial growth is rapid and is protected from all irritation.

Skin grafting by Reverdin flaps was tried in case 6, with open air under a screen. The attempt was unsuccessful, but adhesive dressing was later substituted followed by rapid healing. Unfortunately a number of patients developed influenza during the course of treatment. It was noted in all cases that healing practically stopped till recovery was complete.

CONCLUSIONS

In the first aid care of extensive burns, the dressing with gauze soaked in 10 per cent. or stronger sodium bicarbonate and kept moistened is the simplest and gives greatest comfort. This is preferable to attempts at a more complicated technic. Morphine should be used to give rest but must be administered with care since there is often severe reaction and depression and the drug may do harm. Treatment of shock with posture, heat, hot drinks and stimulants may be necessary.

Paraffine is much preferable to gauze with oily dressings and should be substituted as soon as possible, at least within thirty-six hours. With the use of the air pump and atomizer the method can be simplified and rendered quite painless, dressings on gauze should be abandoned.

Dichloramine T in oil is painful and of slight value. If there is extensive slough, wet dressings or antiseptic powders are preferable.

The use of adhesive strapping over the raw surface is highly satisfactory and simplifies the treatment since dressings may be extended to two or three days.

The general conditions of the patient must be carefully followed and built up by stimulants, tonics or transfusions.

Skin grafting is rarely necessary nor does it offer much advantage to the healing with paraffine or adhesive.

THE INITIAL TREATMENT OF WAR WOUNDS INVOLVING THE KNEE-JOINT

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This paper will be more intelligible if it is introduced by definitions of a few of the terms employed in war surgery. For example:

1. A *perforating wound* is that which goes through and through and which has, therefore, no retained missile.

2. Conversely, a *penetrating wound* has a wound of entrance but none of exit. The missile is retained.

3. *Débridement* consists of the excision of the injured and contaminated tissues, either soft or bony, of a wound track. It implies, as a rule, the removal of the missile and of other foreign bodies, such as clothing.

4. A *primary suture* is a complete closure done at the time of an initial operation.

5. A *delayed or retarded primary suture* is a complete closure done from three to five days after an initial operation.

6. A *secondary suture* is a complete closure done ten or more days after an initial operation. Both delayed primary and secondary sutures imply that, at the initial operation, a wound has been left open for drainage.

7. *Bullet wound* signifies a wound made by a revolver or machine gun. Shrapnel balls are practically a thing of the past.

8. *Shell wound* signifies a wound made by a fragment of the casing of a high-explosive shell.

This study of knee-joint wounds is based on cases coming to an Evacuation Hospital, cared for either by myself or by one of my associates. All were fresh from the battlefield, with the primary dressing still in place. On the average they have come to the operating table fifteen hours after being wounded, three hours and thirty-seven hours being the two extremes.

1. STATISTICS ON TYPE OF MISSILE

In this respect the cases may be differentiated:

Bullet wounds without fracture	6
Bullet wounds with fracture	18
Shell wounds without fracture	22
Shell wounds with fracture	42

2. STATISTICS ON TYPE OF WOUND

Perforating without fracture	14
Perforating with fracture	10
Penetrating without fracture	10
Penetrating with fracture	46
Gutter without fracture	4
Gutter with fracture	4

3. STATISTICS ON TYPE OF FRACTURE

Fracture, femur	30
Fracture, tibia	6
Fracture, patella	10
Fracture, femur and patella	4
Fracture, femur and tibia	4
Fracture, femur, tibia and patella	6

4. SUMMARY OF STATISTICS

Let me condense these findings in this way:

(1) Shell wounds (72 per cent.) are more common than bullet wounds.

(2) Fracture in the joint (68 per cent.) is more common than non-fracture.

(3) Penetrating wounds (70 per cent.) are more common than perforating.

(4) Penetrating wounds usually fracture. In other words, a missile which hits the bone usually stops (82 per cent.).

(5) Fracture of the femur is the most common fracture (48 per cent.).

(6) The most frequent lesion, then, is a penetrating shell wound with fracture of the femur.

5. GENERAL RULES FOR TREATMENT OF ALL WOUNDS OF KNEE-JOINT

Certain general rules apply in the initial treatment of all wounds of this joint. I would offer the following:

A Röntgen-ray examination should precede every operation.

Every knee-joint operation should be done with a tourniquet. Preliminary extrusion of blood with an Esmarch bandage, winding from the foot upwards, is desirable. A dressing is to be applied, at the conclusion of an operation, before the tourniquet is removed.

In case an error in diagnosis is made whereby an intact joint is inadvertently opened, one should immediately suture the false opening.

A culture should be made of every opened joint. Immediate information may be had from a smear. (I regret to say that this rule was broken in many of the cases in this series.)

Ether is not an antiseptic. If joint irrigation is necessary, saline solution serves every purpose. The retention of antiseptic fluids in a joint is contra-indicated.

Wicks, rubber tubes, or strands of silkworm gut may be placed in the periarticular tissues to the synovia but should not enter the joint.

At the time of operation a definite policy of treatment and of after-treatment should be adopted. The incision to be used, the necessity of resection or of amputation, the matter of open capsule or of closed capsule, the decision for or against post-operative mobilization—these must be items in an intelligent, clear-cut scheme. Otherwise, a surgeon

may spend some time in careful débridement, only to find that amputation above the knee is necessary. Another may not have determined whether he is trying for a movable or for a stiff joint.

Cases are best kept under the observation of the operator for at least ten days after operation.

6. NON-OPERATIVE AND OPERATIVE TREATMENT OF CLEAN, PERFORATING BULLET WOUNDS

The method of treatment of a fresh wound of the knee-joint depends primarily on the presence or likelihood of sepsis. Frank sepsis seldom occurs in the early hours after injury; latent sepsis is to be feared if the preoperative period has been long or if the missile is dirty. Shell fragments are more prone to cause sepsis than are bullets. Secondarily, treatment depends on the existence of fracture, the retention or non-retention of the missile, on the scope of the wound and on the general condition of the patient; for these factors modify the amount of débridement, the nature of an incision, the time to be expended.

If the presence or likelihood of sepsis is of primary consideration, our cases divide themselves summarily into two classes:

1. Perforating bullet wounds, usually clean, and
2. All other wounds, prospectively septic.

Bullet wounds of the knee cause joint infection in only about ten per cent. of the cases in which this lesion prevails. Yet bullet wounds in soft tissues are rarely sterile,* so that we must fall back on the established fact that the knee-joint itself can overcome low-grade infection. Bullets cause less splintering of bone than do shell fragments.

I believe, therefore, that in the absence of acute inflammation, a knee-joint which exhibits a perforating wound, without extensive fragmentation, caused by a bullet, may be left alone. Otherwise, with every penetrating or perforating wound, the knee-joint should be opened.

Usually, however, even the simple, perforating bullet wounds are accompanied by a considerable bloody exudate into the joint cavity. It is well, then, to adopt one of the two following methods:

(1) One may aspirate, make a culture of the aspirated fluid and immobilize on a posterior wire (Cabot) splint. After a few days active movement may be inaugurated. Reaccumulation of fluid suggests, of course, further aspiration. Oncoming sepsis in the joint is a signal for free incision.

(2) One may excise the peri-articular tissues about the entrance and exit wounds, allow the joint exudate to escape and immediately suture tightly the three layers—synovia, capsule and skin. It is legitimate, before suturing, to wash the joint cavity through a catheter.

* Of one hundred consecutive cases, many of which were bullet wounds, B. Welchii was recovered in eighty-five.

7. OPERATIVE TREATMENT OF ALL OTHER TYPES OF WOUND

a. General Outline of Operative Technic.—An operation, roughly, comprises the following steps:

(1) Application of Esmarch bandage. Application of tourniquet.

(2) Removal of Esmarch bandage.

(3) Preparation of operative field.

(4) Débridement of missile track, both soft tissues and splintered, unattached bone fragments. Each fragment is removed which has the ear-marks of a prospective sequestrum. Evacuation of fluid and blood clot.

(5) Removal of missile, if it be present, together with bits of foreign material carried in with the missile. It is seldom difficult to find the missile in this particular joint. It is fair to say that a clean missile—a bullet—imbedded in bone is often tolerated. Yet even missiles of this category would best be removed unless their removal involves marked bone destruction. It is of paramount importance to remove such foreign material as bits of clothing.

(6) Irrigation of the joint. Personally, I irrigate only septic or dirty joints.

(7) Complete or partial closure of synovia, capsule and skin.

(8) Application of dressing and sometimes of a splint. The customary dressing is dry gauze or gauze wet in Carrel-Dakin solution.

(9) Removal of tourniquet.

b. The Several Incisions.—In opening a joint it is essential to procure a complete approach to all injured areas. Whenever possible, one should make first a liberal lateral incision well outside the patellar edge, incorporating in the incision the entrance wound of the missile. If this be done, a single incision may suffice for the several operative steps. Sometimes, in long ranging wounds, this is impossible and the incision is made through the exit wound or through uninvolved tissue.

If a single lateral incision gives inadequate access, a second lateral incision may be made beyond the opposite patella edge. Better still, one may employ the familiar U-shaped incision, cutting the patellar tendon close to its insertion, but cutting it in a somewhat oblique direction in order to give a broad surface for later coaptation. A missile lying free in the joint may usually be extracted through a single lateral incision.

Never hesitate to make a U-shaped flap for cases of extensive injury. Never fail to resuture the patellar tendon. In so far as is expedient resuture the lateral aspects of the flap.

A median incision, splitting the patella longitudinally, has not been used in any of the cases in this series.

c. Débridement.—To procure adequate débridement one must always follow the missile track. It may be found desirable, secondarily, to remove a missile through a counter-incision; but do not acquire the habit of merely cutting down through clean tissue over a foreign body.

For a missile lodged proximally in condyle or tuberosity, the ideal operation is to débride the track to the bone and to chisel out both missile and adjoining bone *en masse*. A margin of an eighth of an inch of good bone should be removed with the missile. This method is preferable to that of first removing the missile and then attempting to remove dirty bone with a curette.

d. Fractured Patella.—Avoid resection of the patella. Dirty bone along the edges of the track may be rongeured away. If the broken fragments are large, suture the periosteal edges with catgut. For extensive destruction perform a subperiosteal resection.

e. Resection.—In the past, primary resection of the knee-joint has been common both in clean and in infected cases. This teaching has been supplanted by the following:

Avoid primary resection of the knee-joint. It is indicated only for complete or nearly complete destruction, in clean cases, of the lower end of the femur or of the upper end of the tibia. A movable joint seems to be a possibility if two-thirds of either or both of these surfaces remain intact. After resection the knee-joint should be immobilized at an angle of 35 degrees.

f. Amputation.—One must consider primary amputation, rather than simple drainage or resection, for a streptococcus infection of the joint or even for a gas bacillus infection. For other less critical infections, amputation, if necessary, may be done as a secondary operation. Primary amputation, in short, is demanded for two conditions only: Severe joint infection and for complete blood-vessel destruction in the popliteal region.

8. CLOSURE

a. Primary Suture.—If our operation has been other than amputation we are confronted with the question of joint closure. The operative wounds may be closed by primary, by delayed primary or by secondary suture; or they may be left open for a more protracted period for the sake of drainage. We are advised by the army authorities that the capsule, but not the outlying soft tissues, should be closed by primary suture when possible. When, then, is it possible?

Primary suture is possible except when there is:

(*a*) Infection with streptococcus, staphylococcus, gas bacillus or other similar noxious organism, shown by smear or by culture.

(*b*) Extensive destruction of capsule.

(*c*) Large or dirty missile, especially a fragment of shell.

It is possible but not definitely indicated when there is a large amount of fluid and blood clot in the joint.

b. Delayed Primary and Secondary Suture.—If primary suture is contra-indicated, one must then decide, for each individual case, whether the

joint may be closed by delayed primary suture, by secondary suture or must be left open more or less indefinitely. Setting aside the mechanical difficulty of loss of capsule, the question becomes one of the time required to abort or eliminate infection or to get rid of superfluous blood clot and fluid. In other words, a joint must be relatively sterile and relatively empty before it may be closed; suppuration must have ceased; especially must the discharge from the joint give a negative culture for streptococcus.

Delayed primary suture gives an end result as good as that of primary suture. By delayed primary suture the end result is attained more speedily. Delayed primary suture largely eliminates the difficulty of diagnosing prospective sepsis. In my experience the danger of infecting a clean joint, which has been left open, is nil. For these reasons, in my own cases, I am leaning more and more away from primary suture towards delayed primary or secondary suture. I close by primary suture only two types of lesion: (1) Wounds, with little or no fracture, which are sterile on smear. These are usually penetrating bullet wounds. (2) Joint resections.

To these narrowed limits some of my associates would not agree. They are inclined to adhere more rigidly to the specifications set forth under 9, *a*. And it is true that one sees cases like those described as Cases 9 and 10 make an excellent recovery after being closed by primary suture.

c. Frank Sepsis.—Yet when I am in doubt I leave an opening. If frank sepsis exists, it is desirable to have liberal drainage at either side of the patella—so liberal that it drains both the lateral aspects of the joint and the suprapatellar pouch. Drainage may be needed for a considerable time and one must be on his guard against pocketing in the posterior portion of the joint, in the calf of the leg or in the thigh. If frank sepsis does not exist, a shorter incision at one or the other side of the patella suffices—preferably an incision on the side of the entrance wound which exposes, if such exist, injured bony areas. If the incision has been extensive, if one has used, for instance, a U-shaped incision, it is customary to resuture in part. The synovia may be closed with continuous catgut, the capsule with interrupted catgut, the skin with silkworm gut. The patellar tendon and that portion of the capsule immediately adjacent should always be resutured.

Drainage through the posterior aspect of the knee-joint, as an initial procedure, is indicated only when the wounds of entrance or exit involve this region. If such involvement is present, and wicks or tubes are placed to the capsule posteriorly, one must bear in mind the possibility of secondary hemorrhage. Personally, I use no wicks or tubes in the popliteal space. A wide-open, posterior wound, in itself, has sufficed.

So much for the question of closure. It is closely affiliated with the problem of mobilization and immobilization.

9. IMMOBILIZATION AND MOBILIZATION

A tightly closed synovia connotes temporary immobilization. With two exceptions, an open synovia connotes immediate, conscientious, systematic movement. The exceptions are these:

a. If there is extensive destruction of joint surface, it is necessary to immobilize, even though the synovia is not completely closed. Conversely, in the presence of slight bone injury, if one is aiming for a movable joint, immediate movement is advisable.

b. If there is complete fracture of the patella or if there is an injury or an incision which severs either the patellar or quadriceps tendons, it is necessary to immobilize, even though the synovia is not completely closed.

The exceptions we have noted are illustrated by Case 11 or by Case 12.

Let me make this rule more specific, more emphatic, by looking at it from the reverse direction. Temporary immobilization (splint) is indicated for: *a.* Closed synovia, including non-operative cases (Case 2), joint resection, and all other cases closed by primary suture (Case 7). *b.* Complete fracture of the patella or injury or incision which severs either the patellar or the quadriceps tendons (Case 5). *c.* Extensive destruction of joint surface (Case 12).

Mobilization (no splint) is indicated for: *a.* Septic joints. *b.* All cases, except those enumerated above, treated by delayed primary or by secondary suture (Case 8).

Immobilization is happily secured by a Thomas splint slightly bent at the knee or by a posterior wire (Cabot) splint. The Thomas splint affords traction; the Cabot splint does not. Simple cases should be immobilized for at least three days. Thereafter, movement must be gradual. Too free movement leads to accumulation of fluid in the joint.

Undue distention of the joint capsule at once suggests aspiration. Too little effort is made to relieve synovitis or hæmarthrosis in this way. One may aspirate on slight provocation and culture. If the aspirated fluid shows gas bacillus, staphylococcus, streptococcus or other virulent organism, the joint must be opened. Diplococcus alone does not warrant opening a joint. Yet, even in the absence of the more virulent organisms, I have not infrequently made an incision, to be closed a few days afterwards. My results have been satisfactory. Here again, I lean towards delayed primary suture.

If mobilization has been elected, it must be begun within a few hours after the operation, as soon as a patient is out of his anæsthetic, and must be performed systematically and conscientiously. If the joint is allowed to rest immobile for two or three days—even for twenty-four hours—it becomes recalcitrant. It resents any attempted movement—becomes red, swollen and tender. Usually the attempt must be temporarily or permanently abandoned. On the day of the operation, then, and from two

to four times a day thereafter, under supervision, the patient is instructed to lie flat on his back, lock both hands at the posterior surface of the lower thigh and elevate to a right angle both leg and thigh, the knee being in extension. Thereupon, with the thigh still upright, the leg is allowed to drop until it is at least horizontal; better still, it is allowed to drop until the heel is within a few inches of the bed. During this movement, at first, the surgeon must place the palm of his hand under the heel to give partial support.

Most patients are fearful of this procedure. They complain, however, of stiffness rather than of severe pain, and with initial coaching, assistance and encouragement, can easily be taught to perform the manœuvre. A patient should be made to walk, with a cane, on the second or third day after operation. The first day he takes a few steps, the next day he walks around his bed, the third day, perhaps, the length of the ward. Once only I have seen a slight chill and an elevation of temperature (104 degrees) follow this procedure. The following morning the temperature had subsided.

After delayed primary or secondary suture has been performed, one must regulate motion carefully. We have here a condition analogous to that described in Case 13.

Mobilization is especially important in septic joints. Immobilization of a septic knee is often a forerunner of amputation. Adequate drainage of a quiescent knee is so difficult that a profound and obstinate sepsis, with joint erosion, is apt to develop. Pus pockets are discovered. Septicæmia ensues.

Per contra, mobilization cures sepsis. Active joint movement squeezes out joint pus in a surprisingly effective way and, in many instances, leads to a rapid subsidence of acute symptoms. Mobilization prevents stiffness. Employed from the beginning, it gives mobility without undue discomfort after a relatively brief interval—often after a few days. The result is quite in contrast with that of a splinted patient, with his stiffened, sensitive knee, who must recover strength, reacquire, if possible, motion in his joint, and undergo, at best, a protracted convalescence.

The following case reports illustrate a few of the methods advocated and some of the results secured in this series:

CASES I and II.—*Method employed for simple perforating bullet wounds.*

CASE I.—Perforating bullet wound passing through crural pouch. Five hours old. No culture. *Operation.*—Entrance and exit wounds excised. Closed tightly. Thomas splint. Movement begun after five days. Normal convalescence. Reported three weeks later that he was walking and had no material symptoms from knee.

CASE II.—Perforating revolver bullet passing beneath patella. No fracture. Slight hæmarthrosis. Eighteen hours old. No culture. *Operation.*—None. Aspiration not deemed necessary. Thomas

splint applied. Discharged from hospital two days later. Knee doing well.

CASE III.—*Method employed for long, ranging wound.* Perforating shell wound. Small fragment. Duration not known. Entrance: Left leg, middle third, inner surface. Passed upwards, drilling tibia, external condyle and outer edge of patella. *Operation.*—U-shaped incision. Loose bits of external condyle removed. Patellar edge rongeured. Joint irrigated. Patellar tendon sutured. Incision on outer side left partly open for drainage; closed on inner side. Entrance wound debrided. Rubber tissue drain. Cabot splint. Discharged from hospital after two days. Doing well.

CASE IV.—*Débridement en masse of missile lodged proximally in condyle or tuberosity.* Penetrating shell wound, external aspect of knee. Sixteen hours old. Röntgenogram shows small piece of shell located in central portion of external condyle. Extensive fracture of external condyle. *Operation.*—U-shaped incision including entrance wound. Patella thrown upwards. Knee-joint flexed. Portion of external condyle with shell fragment chiselled out en masse. Inner side of incision resutured in layers. Patellar tendon resutured. Outer side of incision left open for drainage. No splint. Loose dry gauze dressing. *After-treatment.*—Patient encouraged to move knee. Abundant serous discharge. No infection. Discharged from hospital four days after operation in good condition.

(If this patient had been under my care, I should have employed a lateral incision and have held the man until the time was ripe for delayed primary suture; a U-shaped incision suggests temporary immobilization.)

CASE V.—*Suture of fractured patella.* Perforating bullet wound through the patella. Nineteen hours old. Considerable fluid in joint. Röntgenogram shows patella shattered. *Operation.*—U-shaped incision. Joint evacuated and washed with ether. Periosteum of patella sutured with catgut. U-shaped incision resutured, leaving strands of silkworm gut in the superficial tissues. Cabot splint. Patient discharged from hospital the ensuing day in good condition.

In Case V the culture from the joint was negative.

CASE VI.—*Amputation for severe infection.* Gutter wound caused by shell fragment. Quadriceps tendon torn away and joint opened widely. Joint infected with gas bacillus. Röntgenogram shows fracture of the femur just above the condyles. *Operation.*—Guillotine amputation of lower third of thigh. *After-treatment.*—Discharged from hospital, in good condition, four days after operation.

CASE VII.—*Simple primary suture.* Penetrating shell wound. Fifteen hours old. Small amount of fluid in joint cavity. Röntgenogram shows small foreign body lying loose between condyles. No fracture. *Operation.*—Lateral incision including entrance wound. Debridement of track. Joint fluid evacuated. Foreign body removed. Wound closed tightly in layers. Thomas splint. *After-treatment.*—

Gradual motion begun in joint after three days. Discharged from hospital ten days after operation. No untoward symptoms.

CASE VIII.—*Delayed primary suture.* Penetrating shell wound, opposite external condyle. Six hours old. Röntgenogram shows missile lodged against outer surface of condyle. No fracture. *Operation.*—Short lateral incision including wound of entrance. Débridement of track. Removal of foreign body. Smear shows no organisms. Wound left open. Active motion of joint inaugurated. *After-treatment.*—Four days later a culture of joint excretion gave no growth. Knee comfortable. Opening already partly obliterated by granulation. Opening closed in layers; catgut for syonvia and for capsule, silkworm for skin. Discharged from hospital five days after operation in good condition.

CASES IX and X.—*Disillusionment sometimes encountered after primary suture.*

CASE IX.—Perforating shell wound, entering opposite internal condyle. Twelve hours old. Röntgenogram shows slight fracture of internal condyle. *Operation.*—U-shaped incision. Fluid and blood-clot evacuated. Loose fragment of internal condyle removed. Wound closed tightly. No culture taken. *After-treatment.*—Three days after operation violent inflammatory reaction in knee. Culture from aspirated fluid shows streptococcus. Amputation at mid-thigh. (This patient had also a penetrating wound of the spinal canal from which he developed a fatal attack of meningitis.)

CASE X.—Penetrating shell wound with fragment lodged in patella. Twelve hours old. Röntgenogram shows compound, comminuted fracture of patella. *Operation.*—U-shaped incision. Shell fragment removed. Patella reformed. Patellar tendon resutured and wound closed by primary suture. *After-treatment.*—Three days later joint badly infected. No report on culture; probably staphylococcus. *Second Operation.*—Patella taken out. Lateral incisions for drainage. Carrel-Dakin tubes. Cabot splint. Patient evacuated a few days later. No later report. He unquestionably developed much erosion of the knee-joint and probably came to amputation.

CASE XI.—*Drainage posteriorly by wide open wound without tubes.* Perforating shell wound. Entrance in popliteal space. Exit anteriorly near the outer, lower corner of the patella. Eleven hours old. Popliteal vessels exposed in posterior wound. External popliteal nerve cut. Röntgenogram shows transverse fracture of femur just above condyles with comminution of external condyle. *Operation.*—Débridement of posterior wound. Nerve sutured. U-shaped incision anteriorly. Fluid and blood-clot evacuated. Bony fragments of external condyle removed. Joint closed anteriorly except for short opening which included wound of exit. Posterior wound left wide open. Thomas splint. *After-treament.*—On fifth day after operation delayed primary suture of posterior wound. Evacuated in good condition on the seventh day.

CASE XII.—*Exception to the rule that an open synovia connotes*

movement. Penetrating shell wound, outer side of knee-joint. External tuberosity destroyed. External popliteal nerve severed. Three hours old. Smear shows diplococcus. *Operation*.—U-shaped incision. Débridement of track. Shell fragment removed together with the greater part of the external tuberosity. Edge of patella rongeured. Popliteal nerve resutured and buried in muscle. Patellar tendon resutured. Inner side of incision resutured. Outer side left wide open. Cabot splint. *After-treatment*.—Patient discharged from hospital two days later in good condition.

CASE XIII.—*Effect of early excessive movement in joint closed tightly*. Perforating bullet wound, inner side of knee-joint. Perforation of internal condyle, without fragmentation. Eight hours old. *Operation*.—Débridement of entrance and of exit wounds to bone. Escape of small amount of fluid from joint. All layers closed tightly. Cabot splint. *After-treatment*.—Immobilization continued for two days. Movement, evidently in excess, caused marked synovitis. Aspiration. Culture gave no growth. A further period of immobilization, followed by more gradual movement, procured better results. Discharged from hospital ten days after operation in good condition.

SUPPURATING CYST OF THE URACHUS, WITH CONCRETION

By William G. Ward, M.D.
of East Lynn, Mass.

The patient was a woman, forty-four years of age, who, however, appeared to be fifty-four. She had been working as a stitcher the past year in a factory, making heavy duck sundries for use in army accoutrements. She had always been a very active woman. Her past history was excellent. She had not passed the menopause. Her present illness was thought to run back some eight weeks. She first consulted a physician about two weeks before I saw her, because of pain and discomfort in and around the navel. This pain was intermittent in character at first, later becoming almost continuous, causing her to walk bent forward. She lost her appetite at the time; became emaciated; had "chills and fever"; did not sleep very well.

On examining the patient I found her to be a very thin and wrinkled, highly nervous type, middle-aged woman. She had a dry, coated tongue. Skin sallow, conjunctivæ clear, and no jaundice. Heart and lungs negative. For the last ten years she had had considerable discomfort from moisture in the umbilicus, which at times was very offensive, smelling like urine. She had to wear a cloth pad over the navel all that time, and every day had to cleanse the parts to prevent irritation.

At this time she is unable to walk upright on account of the pain and swelling in her navel. She says her sleep is now broken by severe contracting pains in the umbilical region. She has become very much depressed, mentally, and has no inclination for food.

On examining the abdomen, I found a tumor mass, round in shape, about the size of an orange, which was just below the navel, and apparently in direct contact with its lower border. The umbilical wall is obviously somewhat elevated and reddened. The floor of the umbilicus is bathed in a thin, watery pus, and an odor of urine is present. The tumor mass feels hard and brawny, and is slightly movable sidewise, with apparent fluctuation. The skin over this tumor shows some slight redness and inflammation. There are no signs of any abdominal complications. There is no swelling of the inguinal glands. Her menstrual periods are still normal. The kidneys are normal. She has had no miscarriages. There is no specific history.

November 20, 1918, a median incision was made from the edge of the umbilicus to the pubis. The abdominal wall being very thin, I expected to enter the cyst easily, but was surprised at its density. The walls of the cyst, as I cut through, had a fibrous, rough, gritty feel. On entering the cyst cavity, about eight ounces of a yellowish, very fetid pus exuded. At the umbilical end of the cyst, I found and evacuated an oval-shaped mass, in consistency strikingly like fine yellow cornmeal. This mass was about one and a half inches long and three-

quarters of an inch wide, and about one-half inch thick. The removal of this oval mass disclosed a very small aperture, opening directly on to the floor of the umbilicus. This opening would admit the point of a fine probe. The cyst cavity would measure about three inches long by two inches wide, and its walls were remarkably smooth without any roughness in any of its parts. The cyst was closely adherent both to peritoneum and fascia, and I did not attempt to dissect it out. The urachal opening I did not attempt to tie, on account of the tenacity of the surrounding tissue. I simply swabbed out the cavity with tincture of iodine, and packed with iodoform gauze. The patient began to improve in health almost immediately; the wound healed rapidly from the bottom, so that in about ten days no more dressing was needed, and in two weeks she was discharged with a firm scar. I noticed, with surprise, how quickly the thick fibrous wall of the cyst disappeared. I should say all the thickness apparently melted away in about four or five days.

The oval mass had acted as a sort of a ball-cock; when it moved it would allow a small amount of urine or pus to flow into the umbilicus through the tiny opening. For several years, the patient told me, she had frequent desire to urinate, but as soon as the abscess formation began this desire had ceased and urination became normal.

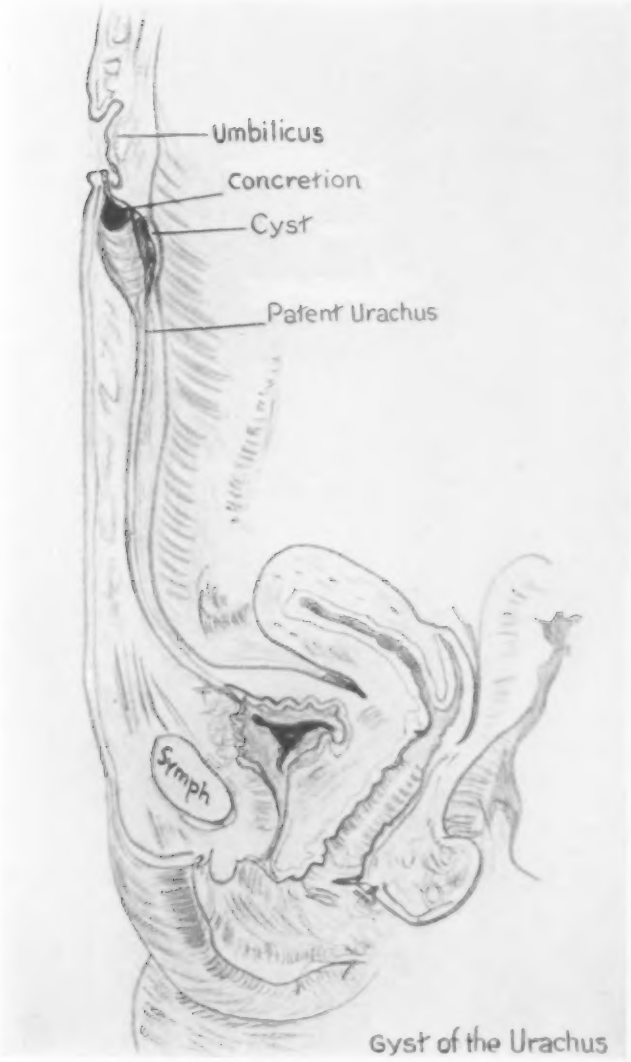
Umbilicus
Concretion
Cyst
Patent Urachus
Symph
Cyst of the Urachus

FIG. 1

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting, held January 8, 1919

DR. CHARLES N. DOWD in the Chair

PERINEAL PROSTATECTOMY

DR. PARKER SYMS showed four consecutive cases of perineal prostatectomy to illustrate results obtainable by this method. The patients all showed great improvement in general health. The surgical results were most satisfactory. All these patients have fully restored bladder function. Each one had full bladder control a few days after operation.

They varied in age from fifty-two years to over seventy. They varied in condition from fair general health, to the greatest debility. Two of them were good surgical risks. Two of them were poor surgical risks. One of them was such a poor surgical risk that he did not give him a general anæsthetic, but used novocain locally. They all had retention, and all used catheters. The drainage tube was removed within twenty-four hours in each case. They all had bladder control within a few days from the operation. They were all essentially well within two weeks, but their wounds were still healing. They all went home within three or four weeks. One man went home on the fifth day. As a late result they are all wonderfully improved in health, and they all have perfectly restored bladder function. The first patient exhibited was able to leave the hospital soon after operation. He had full bladder control when the operation was finished. On the third day after operation, he held his urine 12 hours, and then voided voluntarily.

CASE I.—J. M. S., a merchant, aged sixty-eight years, consulted Doctor Syms, March 19, 1918. At that time patient had complete retention of urine. He was being catheterized every six hours. He gave a history of having had frequency and retardation for a considerable time. He had a sudden attack of retention March 10, 1918. At that time, he had 4 quarts of urine drawn with a catheter. When examined by Doctor Syms he was a pale, thin, sickly individual. His general condition was poor. Rectal examination showed an enlarged prostate. The right lobe being noticeably larger than the left, and one could feel a middle lobe. Cystoscopic examination by Doctor Lowsley revealed large intruding lateral lobes with a well-marked sub-cervical lobe protruding into the bladder.

Operation (March 28, 1918).—The lateral and middle lobes were enucleated by the technic usually employed by Doctor Syms. There

was some difficulty in freeing the lobes from the neck of the bladder. However, this was satisfactorily accomplished. A single drainage tube was introduced, and it was evident the patient had retained his bladder control. The prostatic spaces were packed, and the patient returned to his bed. Drainage tube was removed in twenty-four hours. Patient showed bladder control after tube was removed. Patient was sitting up out of bed within forty-eight hours.

On the third day the patient held his urine twelve hours and then voided it spontaneously. On the fifth day, the patient was able to be dressed and to go home. From that time on, he was able to be up and about. His wound healed progressively.

Present condition: Patient is greatly improved in health. He has been able to resume his active business. He has completely restored bladder function, holding his urine four and five hours. Sometimes he urinates once during the night.

Case II.—H. S., aged seventy years, admitted to Lebanon Hospital, November 4, 1918, with prostatic obstruction and complete retention of urine. The patient was in wretched physical condition. He had paralysis agitans, chronic bronchitis with emphysema, and a large inguinal hernia. He had chronic nephritis, with a marked kidney insufficiency. He showed marked evidence of advanced arteriosclerosis. He was considered to be a very poor surgical risk. A general anæsthetic was deemed too dangerous for him.

At operation, November 13, 1918; under local anæsthesia, both large lateral lobes were removed, also a fair-sized middle lobe. Drainage tube was removed within twenty-four hours. Patient showed bladder control by the third day. He urinated partly through the urethra by the end of the first week, holding his water one hour and a half by that time. Discharged from the hospital December 2, 1918 (less than three weeks).

Present Condition.—Patient is remarkably improved in general health. He has perfectly restored bladder function, being able to hold his urine and to empty his bladder without difficulty. His improvement is like a regeneration.

Case III.—A. B., aged fifty-two years, was admitted to Lebanon Hospital November 11, 1918, on account of prostatic obstruction with complete retention. The symptoms of retardation and frequency had extended over a period of about three years. They increased until finally complete retention ensued, and he was dependent on systematic use of a catheter. The patient was a man of fairly good physical condition. His kidneys showed a fair degree of efficiency. He was apparently a good surgical risk. Examination showed an enlarged prostate with complete retention.

At operation, November 13, 1918, at Lebanon Hospital, perineal enucleation of the lobes was accomplished without difficulty. The exposition was very satisfactory, so that the proceedings could be plainly seen and demonstrated. A large peduncleated middle lobe was delivered through the bladder orifice, and brought into view and then removed. The tube was removed within twenty-four hours. The patient was out of bed within twenty-four hours. The patient showed

bladder control, keeping dry for an hour, within five days. He urinated through the urethra on the eighth day. He was discharged cured on December 6th (about three weeks).

Present Condition.—The patient is in good health. He has perfect bladder function. Controls his urine and empties his bladder voluntarily.

CASE IV.—L. S., aged sixty-three years, was admitted to Lebanon Hospital on December 2, 1918, with prostatic obstruction, causing complete retention, with overflow. This patient was a fair surgical risk. His general condition was fair. His kidneys were not badly damaged. Examination revealed a large prostate, with soft lateral lobes.

At operation, December 4, 1918, the lateral lobes were satisfactorily enucleated through the perineum. The proceedings could be plainly demonstrated and seen. There was a pedunculated middle lobe within the bladder, which acted like a ball valve. This was delivered through the bladder orifice, and removed as in the case above. The tube was removed within twenty-four hours. The patient was out of bed within twenty-four hours. He had bladder control, keeping dry about an hour at a time, by the seventh day. He urinated through the urethra by the tenth day. The patient was discharged completely cured on December 30th (four weeks).

Present Condition.—The patient is in good health. He has fully restored bladder function, holding his urine several hours, voiding voluntarily, and in fact, is free from symptoms.

In answer to a question as to what the sexual powers of these men were, Doctor Syms said that he was unable to state off-hand. He further said that this is a very difficult question to answer, because the evidence is usually unsatisfactory. We have to depend for the most part on unreliable hearsay evidence. Where he has gone into this matter in a series of cases, he has been convinced that perineal prostatectomy restores lost sexual function in some cases where it had been absent, and that this function has been doubtless lost in some cases where it had been present before operation. He considered this matter to be one of secondary importance in that class of cases. He believes prostatectomy is performed almost entirely as a life-saving measure. It is really a case of life and death with these patients.

In answer to a question whether after operations by the perineal route a larger percentage of men lose power of control over urination than after operations by the suprapubic route, Doctor Syms stated that he could only answer this in a general way: That his experience had been that the bladder function is restored in the vast majority of cases. He had had only 4 or 5 cases where there had been decided loss of control by the bladder sphincter. If the bladder sphincter is intact after the operation, the patient will have control. One of the patients presented to-night held his urine twelve hours on the third day. At the time of operation, the bladder sphincter closed upon the tube, and there was no leakage around the tube. If the operation is properly and successfully performed, removing nothing but the prostate from the fascial sheath, and not removing prolongation of the sheath, the

sphincter muscle will not be interfered with. If this is so the patient will have full control, and we will have a satisfactory result. By a satisfactory result, he means that the patient is able to hold his urine, and to empty his bladder without difficulty. In other words, he has restored bladder function.

Dr. Chas. N. Dowd said, concerning the control of urine, that in the last case of perineal prostatectomy done by him, it was apparently particularly successful while the man was still in the hospital. He was passing urine through the urethra within ten days; but he afterward came back complaining of incontinence. The operation had been done by the Young method and was done with much care in separating the prostate from its sheath, and still he had this lack of control which was presumably due to the interference with the nerve supply.

Dr. Robert T. Morris stated that he had begun with the perineal prostatectomy and had done most of his work that way until he tried the suprapubic for some cases. Now he almost never uses the perineal route. Concerning sexual power he stated that some patients have lost power which they had before the operation and some have regained it having lost it before operation.

ANEURISM OF THE TEMPORAL ARTERY

Dr. Charles A. Elsberg presented a young man, who had been injured in March, 1918, while working in a dental laboratory. He was struck by a little splinter and noticed a drop of blood in the temporal region. After two weeks he began to notice a throbbing on the right side of his head and soon noticed slight enlargement in his temporal region. In April he had a large pulsating mass in this region. Compression of the external carotid artery stopped the pulsation and stopped the sound in his head. The swelling was chiefly in front of the ear. In April the external carotid artery was tied, the swelling became very much less and the throbbing sound disappeared for a time. But it has now returned together with the swelling in the temporal region, which is of the size now seen and with marked pulsation. Whence is the blood supply? Should an effort be made to extirpate the entire mass?

Dr. Robert T. Morris suggested making a clean cut and removing the aneurismal tumor *in toto*. A great many increased anastomoses with the temporal artery take place when the external carotid is tied. He suggested that this excision be done without interference with the many of the branches of the facial nerve, cutting below and in front of the hair line.

RESECTION OF SUPERIOR MAXILLA WITH PRESERVATION OF HARD PALATE

Dr. John Douglas presented a girl, fourteen years of age. She noticed a growth in right nostril four months previously, which had greatly increased in size until the time of admission to the hospital. It was then about five by three centimetres in diameter and completely filled the right side of the nose, deflecting the septum to the left and completely filling the nasal cavity,

protruding from the right nostril and projecting into the nasopharynx posteriorly. The Wassermann was negative.

On August 13th the growth was separated from the nasal cavity, drawn out in pieces and the nasal cavity well cleaned; when it was found that the growth had taken origin in and projected from the antrum. A frozen section was made from this tumor which proved to be an osteosarcoma. No giant cells were present. Two days later a resection of the superior maxilla was performed in the typical manner, with the exception that, instead of making the usual median incision through the hard palate in the median line, the mucous membrane along the alveolar border of the jaw was divided and the mucous membrane and periosteum separated from the hard palate. An incision was then made through the bone in the median line and the superior maxilla removed in the ordinary way, the flap of periosteum and hard palate being then sutured to the divided edge of the mucous membrane of the cheek with the exception that at the posterior angle, where the hard and soft palate joined, an opening was left for drainage. Through this opening packing was inserted into the space left by the resection of the superior maxilla, thus leaving most of the roof of the mouth in place instead of having the oral cavity continuous with that of the nasal as is usual after a resection of the superior maxilla. This was deemed safe in this case as the growth, while taking its origin from the antrum, did not seem to involve the bone. Before doing the resection an incision was made in the neck and the glands excised and the external carotid artery ligated.

A further microscopical examination of the section removed showed tumor tissue of the same type as previously described, involving the antrum but not involving the bone, although distinct fragments of well-formed bone containing growing bone cells surrounded by a layer of osteoblasts was scattered through the tumor tissue. As before no giant cells were found.

The drainage opening has contracted and become smaller and patient now wears a plate with comfort, and the result is obviously better than if the large portion of the roof of the mouth had been removed, and while this may not be a safe procedure in a number of cases, as when the bone is involved in carcinoma, in this case the results justify the means employed.

RESECTION OF ULNA FOR OSTEOMYELITIS

Dr. John Douglas presented a man, fifty-nine years of age, who, seven weeks previous to his admission, fell to the sidewalk and injured his right arm; five days later pain and swelling caused him to enter the hospital for treatment, the diagnosis at this time being infected hematoma of the right wrist. After this he was treated for two weeks in the Out Patient Department, when an X-ray showed osteomyelitis of the lower end of the ulna, he was then operated on in the hospital, the medulla opened, a sequestrum removed and the medullary cavity lightly curetted and the wound drained. The wound failed to heal and he was readmitted to the hospital on January 18, 1918 (the previous admission having been in October, 1917). At this time

his X-ray showed the bone markedly thick and riddled along its whole shaft with numerous cloacæ. There was a small discharging sinus about midway down the forearm and an old scar of the former operation running down the ulnar surface of the forearm. The small and ring fingers were partially contracted and there was poor flexion in these two fingers. The ulna itself was involved from about one and one-half inches from the upper portion to about two inches from the lower end, the bone was moth eaten and there were five separate cloacæ. A linear incision was made over the former scar along the ulnar surface of the right arm; the periosteum was elevated with a periosteal elevator from the surface of the ulna, it was excised with a Gigli saw at a point one and one-half inches from the upper end and about two inches from the lower end; iodoform gauze was then placed in both ends of the incision and the fascia and skin closed over with interrupted plain sutures, leaving the iodoform gauze as drainage. An anterior basswood splint was applied. There was a large amount of swelling and redness around the wound, evidently due to iodoform poisoning immediately after operation. This disappeared after a few days, but on February 17th, twenty-nine days after operation, he developed erysipelas and was transferred to another hospital. This, however, did not prevent his wound healing, and he returned shortly afterwards with the wound entirely healed.

A few weeks later he returned to his previous occupation of marble cutter in which occupation he used a mallet with the operated arm all day, with little or no pain, and very little disturbance of function.

It was of interest to follow in the series of X-rays the result of this subperiosteal resection. There was no attempt to form a new shaft to the bone. There was a very small amount of growth in the form of a spur from the lower fragment of the *ulna* remaining. From the upper end of the ulna fragment there has been a most curious growth of bone, which started down from the divided upper part of the ulna and then has apparently turned at right angles and now appears to abut against the radius with which it has formed a false joint and is apparently of use in functionating and assisting in the support of the radius and in pronation and supination of the forearm. The erysipelas, which developed about the twenty-ninth day, cleared up in about two weeks, and the patient was back at work six weeks to two months after the operation.

REMOVAL OF ENCHONDROMA FROM FIBULA—BONE GRAFT

Dr. John Douglas presented a woman thirty years of age, who noticed a swelling just above the left ankle one year before admission. It had changed very little in size since she first noticed it, and there was not much pain unless the patient received a blow over the ankle. Other history negative. Examination showed a marked thickening of the lower end of the fibula just above the ankle which appeared to be caused by some central growth of the bone, causing a symmetrical enlargement. X-ray showed what was apparently a bone cyst.

An incision was made lateral to the tumor, the skin flap turned back, the bone opened with chisel, and the cavity which was curetted out was filled with a firm tumor of gelatinous consistency. As the removal of the enchondroma, as it proved to be on microscopical examination, would have left such a cavity that it would have filled with difficulty, and as the outer wall of the tibia was removed, and this would have left the bone weak with a subsequent fracture probable, a bone graft was employed. The bone graft was cut from the upper end of the tibia, on the same side, in such a manner as to fit into the cavity; this was placed in the cavity and the wound closed; the subsequent history was uneventful.

A series of X-rays taken over a period of six months shows in a very interesting manner the growth of the graft to the bone at both ends, and the continued density of the graft would seem to indicate its continued viability and its union with the living bone at both ends, rather than its replacement by new bone.

UNUNITED FRACTURE OF LEG—BONE GRAFT

DR. JOHN DOUGLAS presented a man thirty-two years of age who was struck by an automobile and thrown against a tree and his leg fractured four months before being seen by him. The fracture had been reduced and a plaster case applied at another hospital. After nine weeks it had not united, whereupon another case was applied, and he was recommended to walk with the support of this case. There was no venereal history and the Wassermann was negative.

An X-ray taken at the time he came under the care of Doctor Douglas showed a fracture of the upper third of the tibia in rather bad position, and two fractures of the fibula, one in the upper third, the other in the middle third, with no sign of apparent union at any site of fracture. A longer case was applied and he was given advice to wait two months. On February 8th he reëntered the hospital with his leg in practically the same condition and an X-ray at this time showed no apparent attempt at union. On February 13th, six months after his fracture, an incision was made on a level with the site of the fracture, the fibrous union was broken up and the overriding and marked displacement corrected as well as possible. With an Albee saw a fragment of bone about five inches in length was removed, about two-thirds of which was taken from the portion of the tibia below the fracture line, the rest from the upper portion; this fragment was replaced in the gutter in a reversed position and fastened in place with kangaroo tendon passed through drill holes on each side of the gutter, thus giving firm implantation of the graft. The case was then reapplied.

A series of radiographs taken at various periods afterwards repeatedly shows the progress of the osteogenesis which resulted after the insertion of the graft, with the firm union which has finally resulted. It is of particular interest to note the continued density, at all times, of this graft in the series of pictures taken at various times.

The X-ray taken in April shows marked density of the graft, there apparently having been no absorption. The X-ray taken in May show new bone beginning to form in the fibula. Fifteen months after the fracture and eight months after the operation there is good union, the lateral X-ray at this time shows the graft united and new bone from the end of the graft down to the bottom of the gutter and one space where there is rarefaction or absence of deposit of salts.

FASCIA LATA GRAFT FOR CRANIAL DEFECT

Dr. John Douglas made a report on a patient he had presented before the Society about two years ago. The patient was a young man on whom he had operated for Jacksonian epilepsy, due to a compound fracture of the skull; on account of the adhesions between the cortex of the brain and the dura he had dissected out the adherent portion of the dura and replaced it by a flap of fascia lata to which the fat was attached; this was inserted with the fat side adjacent to the cortex. At the time of presentation of the case the permanence of the cure was questioned. The patient has since then entered the army, been with the A. E. F. in France and been promoted to the position of corporal, and Doctor Douglas read a letter from him stating that he had no further convulsions since his operation.

INJURY OF MUSCULOSPIRAL NERVE

Dr. Robert T. Morris presented a young man, twenty-five years of age, with paralysis of the musculospiral nerve. The man was injured on September 24th, and had a comminuted fracture of the humerus. An operation was done on the same day with removal of some of the fragments. There is now wrist-drop and paralysis of the musculospiral nerve. In the subsequent operation done by Doctor Morris for musculospiral involvement, he exposed the musculospiral nerve through a long incision and found that the nerve for three inches was about one-fourth the entire thickness of the nerve above and below, due to crushing and subsequent constriction by connective tissue. The question arose, should he graft three or four inches of the internal saphenous nerve or should he dissect out this partly good nerve and wrap it in fat or muscle to prevent further compression by the connective tissue. This he had done. The question arose was this the best to be done in this case or are we to look forward to the necessity of grafting the nerve, and the speaker said he would like to have the opinion of the surgeons here upon this point.

Doctor Morris showed an ingenious support for the patient's forearm devised by the patient himself.

Dr. Alfred S. Taylor reported on a case he had of fracture of the humerus which failed to unite, accompanied by paralysis of the musculospiral nerve. The patient had had a fracture of the humerus, due to accident at an army camp. A plaster case had been applied for four weeks and there was no union. Subsequent to this two operative attempts were made to obtain union

of the bone, and following the second operation there was complete paralysis of the musculospiral nerve. This had persisted for about five months when he came under the care of Doctor Taylor. There was total loss of power in the musculospiral, and there had been no form of supporting apparatus used to prevent overstretching of the paralyzed muscles. There was a scar extending along the external border of the right upper arm from the shoulder nearly to the elbow. At operation for repair of the musculospiral nerve that old scar was excised, and proved to be very thick and dense. The musculospiral nerve was exposed in the intermuscular space between supinator longus and brachialis anticus, and was then followed upward. It very soon entered the dense scar just mentioned. It was followed upward carefully, and at no place had been divided at the time of second operation. It was surrounded by dense scar tissue for a distance of 10 cm., starting at a point about 4 cm. above the external epicondyle. Above and below the cicatricial constriction the nerve was congested and somewhat swollen. Its sheath along the cicatricial area was very greatly thickened and the nerve itself correspondingly constricted. When the thickened sheath was split longitudinally it rolled outward, almost like an elastic material, and exposed the musculospiral nerve itself, very much diminished in calibre from the compression, but otherwise without obvious damage. The thickened nerve sheath was dissected away from it throughout its whole length, and then a strip of fat was secured from the same patient and fastened around the nerve by catgut sutures, so as to make a fatty sheath. The wound was then closed, the patient made a good recovery, and got a primary union. The forearm and hand were put on a support, so as to relax the extensor muscles.

About two weeks after his operation he was started on massage, electricity and hydrotherapy, and began immediately to show some evidences of returning power in the musculospiral nerve. The improvement was somewhat slow in rate, but was steady, and when last seen a few months ago he had recovered a very considerable degree of power in the muscles supplied by his musculospiral, and will undoubtedly go on to a complete recovery. Meanwhile the fracture in the humerus has failed to unite, so that a further attempt at correction of the trouble with the bone will be necessary.

Dr. Nathan W. Green mentioned a case of his of delayed union in fracture of the humerus with paralysis of the musculospiral nerve. This patient had regained function after dissecting out and transplanting the nerve. The incision made was a curvilinear incision starting in front of the bend of the elbow and passing outward over the fascial septum between the supinator longus and the biceps and the brachialis anticus.

This allowed the exposure of the lower part of the nerve which was of good size and was easily followed up through the cicatricial tissue in the neighborhood of the fracture. The nerve was then dissected out of the cicatricial tissue for about two inches, when it was lifted out of its bed and easily transplanted.

His recollection was that the portion of the nerve above and below the

imprisoned portion was of normal size, but the latter portion showed evidence of compression.

Dr. James M. Hitzrot reported a case operated on about fourteen months ago for ununited fracture of the humerus with the musculospiral nerve caught in the callus and with loss of function in the nerve distal to the fracture. The nerve was compressed, being larger above and below than at the site of compression. A bone graft was used for the non-union and the nerve was surrounded with fat and fascia taken from the thigh. The patient developed function in the nerve some four months after operation, and developed complete function of the arm in about eight months. In October, eleven months after the operation, while carrying something, he slipped and fell, the arm was twisted under him and he refractured the arm at the point of previous non-union The X-ray showed what was apparently fibrous tissue or cartilage on either side of the fracture. At the second operation, the bone had broken exactly in the same place as the previous fracture. The bone graft evidently had been maintaining the stability of the bone across the line of fracture, as there was no evidence of regeneration from the two ends of the humerus, and the refracture evidently broke the graft which while living bone had not been strong enough to withstand the strain put upon it by the above-mentioned fall. The nerve, which had completely regenerated insofar as function was concerned, was apparently the same size throughout the distance of its exposure, and in the region of its previous compression was free from adhesions and apparently quite normal in appearance.

NOTES ON RUBBER GLOVES

Dr. Robert T. Morris read a paper with the above title for which see page 52.

Dr. Parker Syms said that it is very important that a paper of this sort should be so worded that it could not be used to make trouble from a medico-legal standpoint.

Failure to wear rubber gloves does not constitute negligence. He instanced the fact that one of the most successful and reputed surgeons of Great Britain operates without gloves, and his successful work fully justifies him in that practice.

Dr. Charles N. Dowd said that when bacteriological tests of articles in the operating room are made it is well to have the rubber gloves included. There are two common ways of sterilizing rubber gloves, one by boiling and the other by steam. A third way, by the use of chemicals, is not now in common use. It is well as a matter of ordinary routine to take tests of the operating room and to pay attention to these points.

If the method of boiling is used, care should be taken that the gloves are entirely immersed. If a part of the glove floats above the boiling solution, it is manifest that that part is not properly sterilized. It is subjected to a moderate degree of moist heat but not to boiling solution.

If steam sterilization is used rubber surfaces should not be in apposition,

for the steam cannot get access to such surfaces and they, therefore, are only subjected to dry heat which has far less sterilizing power than compressed steam.

One other point, and that is the question of puncture. If the glove is punctured there is always a possibility of infection through the puncture. If punctures occur they usually come through the end of the first finger. This occurrence may be largely safeguarded by having finger cots sterilized with the gloves and slipped over the index fingers before the gloves are put on, thus making an extra barrier against infection.

Dr. Nathan W. Green said that it was conceivable that the season of the year might have some bearing on the question of gloves. In the very warm season of the year when one is sweating and working hard the hands will be found to be bathed in perspiration inside the rubber gloves; in the cold season of the year when one takes off the gloves after operating the hands will be found dry. Now, if the operator is sweating and the hands are bathed in perspiration inside the rubber gloves, when a puncture occurred, the sweat would be extruded through the puncture and might contaminate the wound more than if the gloves had not been worn.

He said he had made it a practice, where particularly anxious not to run the risk of any contamination, to iodine his gloves. Occasionally after removing the gloves a spot of iodine on the index finger was found where a puncture had been overlooked.

Doctor Syms further stated that, where he had worked in casualty clearing stations, the surgeons used one pair of gloves in operating on case after case, washing the gloved hand with soap and water between operations. In those circumstances it would have been impracticable to change gloves. This method seemed to work very well. The washing of the gloved hand seemed quite as satisfactory as washing the bare hand.

BOOK REVIEWS

NEOPLASTIC DISEASES. A Text-book on Tumors. By JAMES EWING, M.D., Sc.D., Professor of Pathology at Cornell University Medical College, New York City. Octavo of 1027 pages with 479 illustrations. Philadelphia and London, W. B. Saunders Co., 1919.

Neoplastic disease is wrapped up in the history of medicine. Cancer is discussed in the oldest literature of India and Persia. It is mentioned in the Papyrus Ebers (B. C. 1500). The ancients treated it by excision and by escharotics. Hippocrates transmitted a considerable mass of descriptions of tumors. The belief in the humoral origin of these diseases subverted the possibility of anatomic study. An early appreciation of anatomic malignancy is found in Leonides of Alexandria (A. D. 180) who dissected out cancer of the breast with the knife and cautery, cutting in healthy tissue beyond the disease, much the same as is done to-day.

Ewing states that, during the twelfth to the fifteenth centuries the ban of the church fell not only upon dissections of the dead body but upon the practice of surgery also, which could be studied only in private and practised only by nomads, while the monks gave themselves over to translations of Galen's writings and speculations in alchemy, astrology, and magic.

Then during the Renaissance, Fabricius (sixteenth century) differentiated between inflammatory swelling and neoplasm. And so gradually the scientific knowledge of tumors began. This knowledge became formulated upon an anatomic basis when the microscope came into use. Clinical classifications then were superseded. With the development of the achromatic microscope the study of tumors entered a new era.

Although careful histologic studies were made, the pathologists of the middle of the nineteenth century believed that cancer originated from the fluid of the blood. This was Virchow's primary conception. It was believed that the disease was an organized exudate from the blood with overnutrition. When Virchow enunciated his cellular hypothesis, that all cells spring from cells, the continuity of growth of tumors became better understood.

In this work Ewing presents the main features of the origin, structure and natural history of neoplasms. The idea has been held up until very recent time that tumors fall into a limited number of classes and that these classes are not appreciably modified by the different organs in which they occur. Under this conception it was assumed that all fibromas, sarcomas, or cancers, no matter in what organ found, were constant to their type, and accordingly a constant causative agent could be assumed.

Ewing presents tumors as specific diseases in which there are many variations. While the past has been much occupied with the classification and the histogenesis of tumors, the indications are that the twentieth century will be characterized by experimental study of the etiology of tumors, and consequently new knowledge which may be applied to prevention and treatment.

This work discusses the classifications of tumors, the nature of metastasis, the chemistry of tumors, theories of the nature of cancer, special etiological factors, and parasitic theory, and experimental cancer research. It is shown that the greater the variation in type between a tumor and the structure in which it originates the more malignant is the tumor. This is the principle worked out by Hansemann. To illustrate the variations in growth caused by variations in the amount and character of nourishment the author invokes the experiments of Jacques Loeb. These experiments show that a certain leaf when cut into segments fails to develop shoots so long as it remains attached to its stem, but when severed from its stem it puts out a new growth from each segment. This phenomenon is supposed to depend upon the flow of nutriment which ceases to pass from the leaf when the normal channel is destroyed and proceeds to express itself in new outshoots.

The parasitic theory of the etiology of cancer is given the space it deserves. The reviewer recalls well the heated discussion about 1895 on this subject. He recalls how severely he was castigated for his heterodoxy expressed in a paper on "Some Fallacies Inherent in the Parasitic Theory of the Etiology of Carcinoma" (ANNALS OF SURGERY, vol. 17, 1893), and again in a paper entiled "Are the Parasitic Theories of the Etiology of Carcinoma Tenable?" (1893). Now Ewing says: "The parasitic theory reached the height of its popularity as a scientific theory about 1895, but during the last fifteen years it has rapidly lost ground, and to-day few competent observers consider it as a possible explanation of the unknown element in blastomatosis."

The larger part of this book is given to special oncology. Each tumor class is considered. Tumors of special tissues and structures are fully discussed. In the thyroid, epithelial overgrowth is recognized in three forms: (1) simple goitre, (2) Graves' disease, and (3) true tumors. Tumors of the pituitary body are classified as (1) diffuse hyperplasia and focal adenoma, (2) adenocarcinoma, and (3) malignant atypical carcinoma. True tumors of this organ are so uncommon that many of the recorded cases must be regarded as simple hyperplasia. The relations of these diseases to infantilism, giantism, and acromegaly are described. A final chapter deals with teratology.

This book is provided with a full and well-arranged bibliography. It

brings the subject of tumors up to date. It is a valuable text-book. The illustrations are largely from photographs. They are well made and truly illustrative.

The work represents a vast labor on the part of the author. It is of value to the student as a guide from an authoritative source; and to the practitioner of medicine and surgery it makes available an understanding of a field too little studied by either.

JAMES PETER WARBASSE.

MANUSCRIPT FROM ARMY MEDICAL OFFICERS

As stated in the circular memoranda for Editors of Medical Publications issued by the Surgeon General's Office on March 27th and May 22, 1918, it is required by paragraph 423, Manual of the Medical Department, that all medical manuscripts by medical officers, U. S. Army, intended for publication shall be first submitted to the Surgeon General's Office, Washington, D. C., for approval. This regulation, which has been very courteously complied with, to date, is still in force as far as medical officers on active duty are concerned. In the case of medical officers recently retired from active duty, it is requested, as a courtesy to the Surgeon General and in aid of assembling material for the Medical History of the War, that all medical manuscripts based upon military or official records or upon military experience during the war, be submitted as heretofore, to the Secretary, Board of Publications, Surgeon General's Office, Washington, D. C., for record and approval and that such MSS. be accompanied by a carbon copy. Upon approval, the original copy will be forwarded to the journal designated, for publication, and the carbon copy will be filed in the records of the Medical History of the War.

For the Surgeon General:

(Signed) C. R. DARNALL,
Colonel, Medical Corps, U.S.A.,
Executive Officer.

WAR DEPARTMENT,
Office of the Surgeon General,
Army Medical Museum and Library,
Washington, March 20, 1919.

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